POWER

Volume 60 New York, August 19, 1924 *No.* 8

Ready!

WHEN the American fleet arrived on the other side in the late war and the British commander asked the American Admiral when he would be ready, he responded:

"We are ready now!"

What a satisfaction there is in preparedness, in having some time to your credit, in having done and ready the things you may be called upon for, and in being "all set" to do the things you may be called upon to perform.

Micawber's analysis, "Annual income twenty pounds, annual expenditure nineteen, nineteen, six, result happiness. Annual income twenty pounds, annual expenditure twenty ought and six, result misery," applies to time with greater force than to money.

One's income in time is fixed. If it is only enough for the accomplishment of that which is expected of him and he squanders some of it — "result misery!"

If he converts it as it materializes, into accomplishment, training, preparedness, he will be ready to respond when fortune calls or opportunity offers.

It is the things that a man does rather than the things that he is going to do or thinks himself capable of doing, that get him somewhere.

And it takes time to do things.

He can invest it in doing ahead those things that he knows will have to be done some time — in making himself forehanded.

He can invest it in training that will fit him for doing greater things, for rising superior to misfortune, for responding to a call in an emergency.

It is a "grand and glorious feeling," that of being ready.

F. R. Low

Assembling 22,000-Kva. Waterwheel Generator

Erecting the Machine—Special Method of Handling the Field Poles—Adjusting Air Gap to Relieve the Load on the Bearings—Drying Out the Windings and Placing the Machine in Service

BY RALPH BROWN

THE machine consisted of a 22,000-kva. generator driven by two 15,000-hp. overhung Pelton type wheels. The rotor, composed of four cast-steel spiders, was shipped on a well car. Each spider, after being heated in hot water to obtain expansion, was placed on the shaft, as explained in the article "Assembling Generator Rotors" in the April 8 issue. Each polepiece, of which there are 42, was shipped within its respective field coil, six field-pole units being contained in each crate. Shipment of the stator was made in

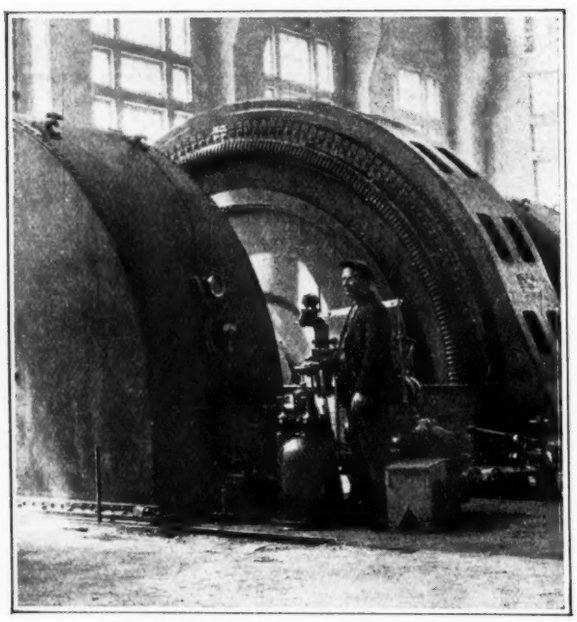


Fig. 1—Generator on dry-out run

halves, on separate flat cars, each section being completely wound except for the frame joint coils, which were inserted after the halves of the stator were bolted together.

All parts such as the field-poles, collector rings, fan sections, bolts, etc., were cleaned and carefully inspected before assembly was undertaken. All tapped holes were retapped to insure clean threads. All parts were assembled with particular regard to the numbers stamped thereon at the factory before the generator, after being tested, was disassembled for shipment.

The sole plates for supporting the stator were set by the generator erector, being accurately leveled by the use of a transit. To facilitate making adjustments of the air gap, these plates were purposely placed low, the desired air gap being obtained by the insertion of thin shims under the feet on the stator frame. After the grouting had set for one week, the lower half of the stator was placed on the sole plates, all machined surfaces that were to come in contact being previously cleaned. The bearings are insulated from the sole plates by leatheroid and pressboard to prevent the flow of shaft currents.

Three weeks after the sole plates were grouted, the shaft, with the rotor spiders, collector rings and waterwheel disks assembled thereon, was lowered into the bearings, these being of the self-aligning, babbitted, water-jacketed type. A substantial scaffold was then built to facilitate the final assembly of the revolving field.

Special Clamps for Handling Field Poles

To avoid clamping the field coils thereon, the polepieces, as uncrated, were placed on the generator floor with the dovetail key upward. Each field pole was turned, Fig. 2, for placement on the rotor by slipping two special iron clamps, attached to a ½-in. steel cable, a few inches from each end of the dovetail key, the field pole then being lifted about two feet from the floor by the main crane hoist. While stationary above the floor the field pole was encircled by a ¾-in. cable sling, wooden blocks being employed to prevent damage to the field coil while it was completely turned by raising the auxiliary hoist hook to which the ¾-in. cable was attached. The field pole was then lowered to the floor, being supported by blocks upon which the brass collar rested, thus preventing movement of the polepiece within the field coil, and the lifting clamps removed. After being balanced if necessary, by moving the sling, the field pole was lifted by the ¾-in. cable and moved to the rotor by the crane operator. While supported from the crane an alternating-current potential of 440 volts was applied between the polepiece and the field coil as a ground test. In making this test a 750-volt voltmeter, in series with four 110-volt 50-watt lamps, was used to indicate possible faulty insulation.

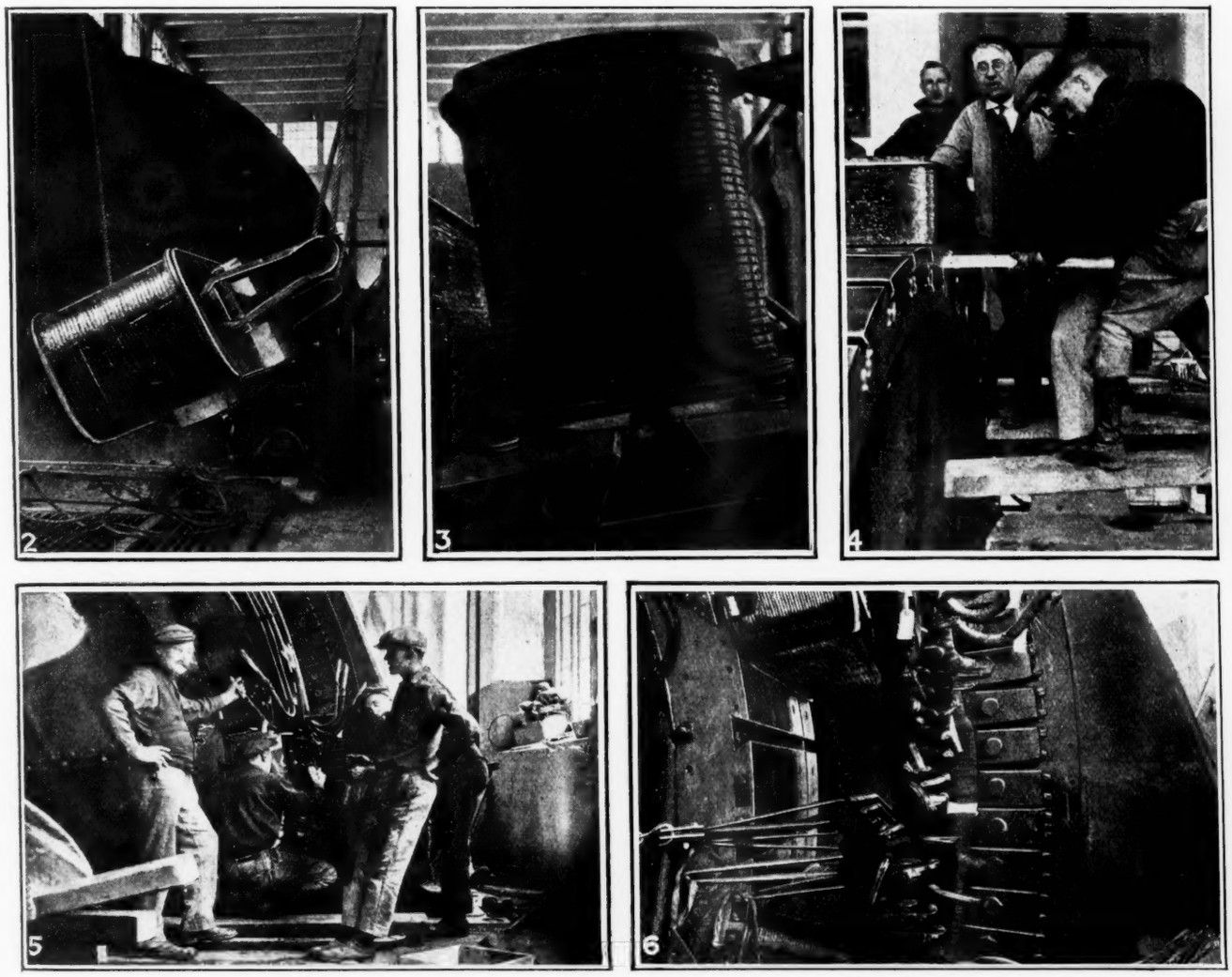
After the rotor slots were painted with a mixture of white lead and engine oil and the eight field coil springs placed in the holes drilled for them in the spiders, a special guide key, Fig. 3, was slipped over the end of the polepiece key, which is of dovetail shape. This guide key kept the end of the brass collar that encircles the polepiece, and is placed next to the lower hardwood collar, from striking the springs, which projected ⅞ in. The springs are provided to compensate automatically for possible shrinkage of the field-coil insulation, thus insuring permanent tightness. The brass collar against which the springs press acts as a damper winding for the suppression of hunting. The key of the polepiece was next entered in the slot, and resting on the guide key, both were pushed about halfway through the slot

by two men, most of the weight being supported by the crane. The hook was then lowered to permit the supporting cable to be moved near the end of the polepiece, and after again being lifted by the crane, the field pole was pushed farther into the slot. After removing the cable sling, the final movement was made by means of a light pair of double-sheath tackle blocks attached to a piece of triple-ply 8-in. leather belting placed around the field coil. By using a short bar the field pole was easily lifted sufficiently to permit withdrawal of the guide key.

The field pole was now pulled to one side of the slot, thus providing space through which one dovetail wedge, liberally coated with white lead, was pushed. The other wedge, similarly coated, was then started in the slot and driven as far as possible by an air hammer fitted with a snap slotted to receive the large end of the tapered wedge, Fig. 4. With an average air pressure of 90 lb. per sq.in. most of the polepiece wedges were driven by the use of the air hammer alone, but an exceptionally tight wedge required the use of a 14-lb. sledge hammer. Care was taken to avoid unnecessarily battering the ends of the polepiece wedges. After the field pole was tightly wedged in position, the winding, before being connected to the adjoining field coil, was again tested for a possible ground at 440 volts. The weight of a complete field pole is 2,500 lb., fifteen poles being placed on the spider and wedged thereto in one day of eight hours. After three field poles were wedged on the uppermost part of the spider, it was turned by the crane to enable the field poles to be placed always in this most convenient position. The waterwheels were blocked to prevent movement due to unbalancing of the rotor during assembly of the field poles.

As is usual with most large generators of this type, no provision is made for shifting the stator in a direction parallel with the shaft, hence the space required for inserting the armature coils in the slots at the frame joints could be obtained only by leaving out two field poles. These two field poles were placed on the spider after assembly of the stator was completed (see Figs. 5 and 6).

To obtain the desired amount of flexibility in the connections between the field coils, the terminals consist of 20 pieces of 2-in. tinned copper ribbon riveted and sweated to the strap-copper winding. Before placing



Figs. 2 to 6—Different operations in placing field poles on rotor

Fig. 2—Field pole and coil being turned prior to placing on rotor. Fig. 3—Field pole being pushed into place on rotor. Fig. 4—Driving field-pole keys with air hammer. Figs. 5 and 6—Making connections in stator winding at frame joints

the field poles on the spider, the flexible terminals were cut to the proper length. The splicers were formed by interleaving the pieces of ribbon, two copper sleeves being used on the top and one on the bottom splice for clamping the leaves. Soldering flux was liberally applied as the splice was made up.

A mixture of shredded asbestos and water was plastered over the surfaces of the field coils likely to be damaged by heating, and the flame from a gasoline blow-torch was directed on the splice. As the splice became heated, half-and-half bar solder and soldering flux was alternately applied thereto, special care being taken to obtain a perfect connection. Due to restricted space, solder could not be as readily applied to the lower splices as to the upper ones, hence in addition to protecting the exposed surfaces of the field coils with the plastic asbestos a small mold of the same material was formed with the fingers beneath and around each lower splice. As this splice became heated by the direct

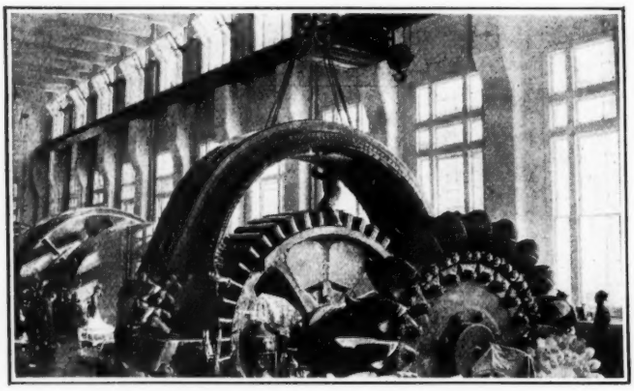


Fig. 7—Lowering top half of stator frame into place

flame of the torch, both solder and soldering flux were applied until the mold was filled, thus insuring the flow of hot solder into the interstices of the splice. Most of the excess solder was drained from the mold into a ladle, the remainder being removed by chiseling and filing. Excess solder was removed from the upper splices by wiping and filing. Each splice was taped with three layers of varnished cambric, one layer of cotton tape, each half-lapped, the insulation being completed by a wrapping of cord. The field winding is connected to the collector rings by two cables supported by hardwood cleats bolted to the spider.

After all but two of the field poles had been wedged in position and all splices between these field coils were completed, the upper half of the stator was lowered into place and the two halves bolted together. The air gap was then adjusted so as to be 0.016 in. less at the top than at the bottom, this being done to reduce the load on the bearings. The total weight of the rotating element is 190 tons. The stator was raised by jackscrews for the insertion of the necessary shims, and similar screws fitted into holes in the sole plates were used to move the stator at right angles to the shaft. When the proper air gap was obtained, the stator was bolted to the sole plates, permanent alignment being insured by fitting one dowel pin in each of the stator feet. Rough measurements of the air gap were made with a tapered gage, calipers being used to obtain exact values.

Since each of the 324 armature coils embraces 6 teeth, it was necessary to lift the sides of 6 coils from the top part of the slots to complete the winding at each frame joint. After the coil sides were removed from the slots, a leather strap was placed around the ends of a coil, one side being pulled away from the stator face to provide sufficient space for the insertion into the slots of the necessary coils. As each coil side was removed from a slot, it was tied to the rotor, Fig. 6.

The coils were sufficiently flexible for handling without being heated, but each coil side was rubbed with paraffin before being placed in the slot. After being carefully entered into the slot, each end of the coil was encircled by a leather strap, and 5-ft. crowbars were used to pull the coil farther into place. When all the coils were inserted, a screw jack was used to insure tightness while the hardwood wedges were driven into the slots.

After wedging, the coils that had been inserted were meggered, and as the insulation was found to be apparently in good condition, a potential test was made by applying 18,000 volts between adjoining coils, and between each coil and the core, after which the connections were completed. Work on the armature winding being completed, the rotor was revolved 90 deg. and the last two field poles put in place. Upon completion of the rotor assembly the field rheostat and connections thereto were checked and found correct.

Methods of Drying Out Generator

Following a run of ten minutes' duration at 20 r.p.m. the generator was operated at speeds ranging from 50 to 80 r.p.m. during the dry-out run, which was continued for 240 hours. Preceding this run the generator leads were short-circuited just beyond the current transformers. The short-circuit current at the beginning of the dry-out run was 1,000 amperes, it being gradually increased to 1,400 amperes to obtain the desired temperature of 80 deg. C. Forty-three per cent of full-load field current was required to produce 1,400 amperes on short-circuit at 70 r.p.m. Megger readings were taken twice daily, 10 megohms at 60 deg. C. being indicated shortly after the dry-out run was started. The dry-out run was discontinued when 16 megohms were indicated over a period of 150 hours, the average temperature being 70 deg. C. At the conclusion of the dry-out the insulation resistance of the 250-volt field circuit was 1 megohm. The differential relays were tested after drying was completed.

With the 6-in. bypass valve at one 42-in. penstock valve wide open ample water was delivered to the nozzle to maintain rotation with short-circuit current flowing. During the early part of the dry-out run the speed was regulated by manual adjustment of the hand-control device. To make speed regulation automatic at the low speed at which the dry-out run was conducted, the governor pulley was removed and replaced with a smaller one. After transferring the control of the nozzle needle to the governor, constant speed was obtained at the low values desired. Owing to the great care exercised in scraping and fitting the bearings before the rotor was revolved by water power, the bearings gave no trouble during the dry-out run.

After removal of the short-circuiting bars the voltage of the generator, while operating at normal speed, was slowly increased to 14,000 volts, and maintained at this value for 5 min. Observers were stationed about the unit during this overvoltage test, and no indications of distress were noted. While operating at 11,000 volts

the generator was connected to the auxiliary bus, and phase rotation, which proved correct, was determined by connecting a three-phase induction motor forming part of a motor-generator set to this bus. The generator was then connected to the system by synchronizing the auxiliary and main buses through an oil switch regularly employed for this service. The generator switch to the main bus was next closed.

When the synchroscope was connected across the closed generator oil switches, the synchronizing connections proved incorrect. Connections were accordingly changed to bring the synchroscope pointer to its correct position, the generator oil switches then being opened. The direction of rotation of the synchroscope pointer was next checked, this being done by changing the generator's frequency a known amount, being guided by both the frequency meter and the tachometer and noting that the synchroscope properly followed these frequency changes. As a final check the generator, operating at normal voltage, was connected in turn to each bus after it had been de-energized, it being noted that the synchroscope pointer then remained in the proper position. This test proving that all synchronizing connections were now correct, each generator oil switch was opened. By paralleling through the oil switch to the main bus, the generator was connected to the system in the routine manner, and the opening of one nozzle was slowly increased until 2,000 kw. was indicated on the wattmeter.

After a few minutes' operation at this output, evidence of heating in one main bearing was detected and the generator was therefore immediately switched out and stopped. Upon removal of the lower bearing shell, its babbitted lining was found to be slightly scored and a few hours of scraping and finishing was required to restore the smooth surface. When repairs had been completed, the generator was again started, but after 50 hours of operation at 80-90 r.p.m. the oil temperature had increased to such a point that the unit was brought to a stop to inspect and scrape the bearing.

After another run of 80 hours, during which the speed was increased from 60 to 172 r.p.m., the generator was connected to the bus and maximum output obtained thereafter without difficulties of any nature. Attachment of the upper halves of the end bells to the stator frame after a thorough inspection of the generator, concluded the work of erection.

Application of Power to Paper Making*

By A. H. White

Chief Engineer, International Paper Co.

In the United States the paper and wood pulp industry ranks fourth in the amount of power; first in power installed in proportion to capital invested in the industry and first in power per employee, namely 16.3 hp. While it stands forth as regards installed power it is second in consumption of power.

Twenty-four hours constitutes a day and a mill is rated on its twenty-four hour capacity. For example, a mill having a normal capacity of 200 tons in twenty-four hours is called a 200-ton mill.

The amount of power used per ton of paper depends upon the sort of paper made. Some papers requiring very little manipulation of stock consume relatively little power; others consume larger quantities of power. In a well designed mill, ground wood can be produced with 80 hp. per ton, that is, 1,920 hp.-hr. In handling and manipulating the stock about 10 hp. per ton is required. Roughly speaking, newsprint contains 75 per cent of ground wood and 25 per cent of sulphite. Thus a ton requires about 1,740 hp.-hr. or, as the paper maker puts it, 72½ hp. per ton.

Paper making requires large quantities of water as a vehicle for conveying the fibres which compose the papers. Therefore, it is natural that the mills be built adjacent to water courses. The majority of paper mills are run by water power, either directly or by electricity generated by water power. In the old days many paper machines as well as the machines for preparing and handling stock were run directly by water wheels.

When steam for drying paper came into use it was soon found that the steam engine would give much better regulation of the paper machine and at the same time reduce the steam pressure to a point suitable for drying purposes. Since the driving of a paper machine requires only 3 to 5 per cent of the heat units in the steam, and as in most cases some live steam is required to supplement the exhaust, the efficiency of the steam engine driving the paper machine has not been of interest.

Probably the greatest and most radical change in the application of power in paper making has been the introduction of the electrical transmission. Years ago the paper makers began to install motors here and there for group driving and for individual drives. Gradually generators were installed in the mills and with the establishment of hydro-electric plants more and more use of electricity was made until today there are mills entirely driven by electric power.

The first attempt at electrical driving was by means of direct current motors, regulated in speed by individual rheostats, the speed of the machine as a whole being regulated by the Ward-Leonard control. The generators were driven by ungoverned water wheels. This method of driving was crude but by careful attention was made to work. The next trial was with induction motors with mechanical speed reduction devices between the motors and the machine shafts. This scheme proved a failure and the problem lay dormant until about six years ago when three methods of sectionalized electric drives came upon the scene. Two of these are really elaborations and refinements of the first direct-current motor plan. The third is radically different in that direct-current motors of slow speed are used, with small synchronous motors opposed to or working with the direct-current motors as the load may vary. The synchronous motors are connected by small cone pulleys and belts to the shafts of the direct-current motors; thus the relative speeds are adjusted and the synchronous motors maintain the established speeds, acting as brakes or boosters as the direct-current motor tends to slow down or speed up.

As only 3 per cent to 5 per cent of the heat units in the steam used in a paper machine is needed for driving the machine, 95 per cent to 97 per cent is used for drying the paper. Therefore, in an electrically driven mill it is economy to generate electricity by steam, using the exhaust from the turbine or engine for drying. Some mills use water power generated electrically for driving the machines and live steam for drying. At any reasonable cost of hydro-electric power this cannot be economical nor are there any advantages to be gained.

*From paper presented at World Power Conference.

Automatic Starting of Synchronous Motors

A New Type of Controller for Automatically Starting Synchronous Motors—Reduced Voltage for Starting Obtained Through Reactance Coils

WHEN starting a synchronous motor, there are in general three major operations to be performed: First, connect the stator windings to partial voltage, usually about 80 per cent of full, and let the motor come up to about 60 per cent of full speed, after which full voltage is applied and the motor brought up to synchronous speed or near the value, when the field switch is closed and the motor pulls into synchronism if not already at this speed. When using manual starting, if these operations are performed by the operator in the proper sequence and at the right time, the motor comes into service with little disturbance on the system and without injury to the motor. The large responsibility placed on the operator in starting the motor has always made automatic starting desirable, and the last two or three years has seen a great deal of attention given to this problem.

One of the recent developments in automatic starting of synchronous motors is that devised by Halbert P. Hill, of Ophuls & Hill, Inc., consulting engineers, New York City. With this system the motor may be started by closing the main oil switch by hand or the switch may be arranged to be closed by a push button. After the oil switch is closed, the starting operations are performed in their proper sequence and at the right time automatically. The control consists primarily of a line oil switch or circuit breaker for connecting and disconnecting the motor from the line; two or three reactance coils, depending upon the number of phases, are connected in series with the stator winding and supply the low-voltage for starting; an automatic three-pole contactor or oil switch that closes when the motor has reached a predetermined speed and short-circuits the reactance and applies full voltage to the stator winding; then at a predetermined time after full voltage has been applied to the motor, the field switch closes automatically and the motor comes into synchronism. In addition to the main switches are the necessary relay and protective devices. The closing time of the switch that short-circuits the reactance coils is controlled by a centrifugal switch in a third slip ring that is placed on the rotor's shaft in addition to the two field rings.

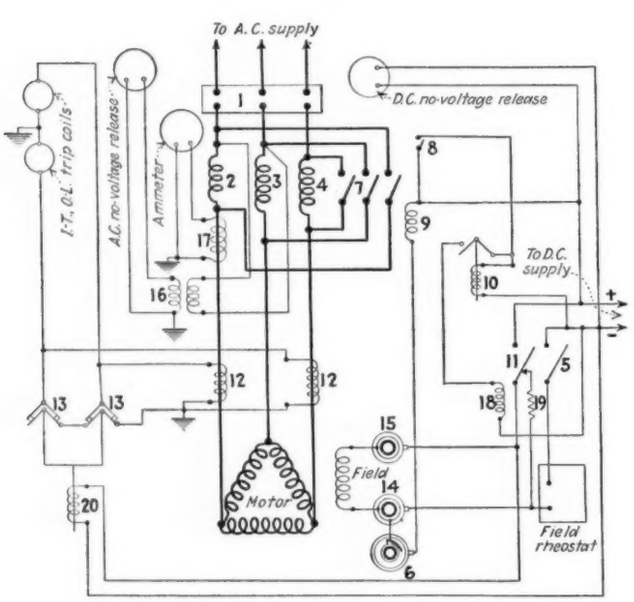


Fig. 1—Diagram of starter connections with all switches in off position

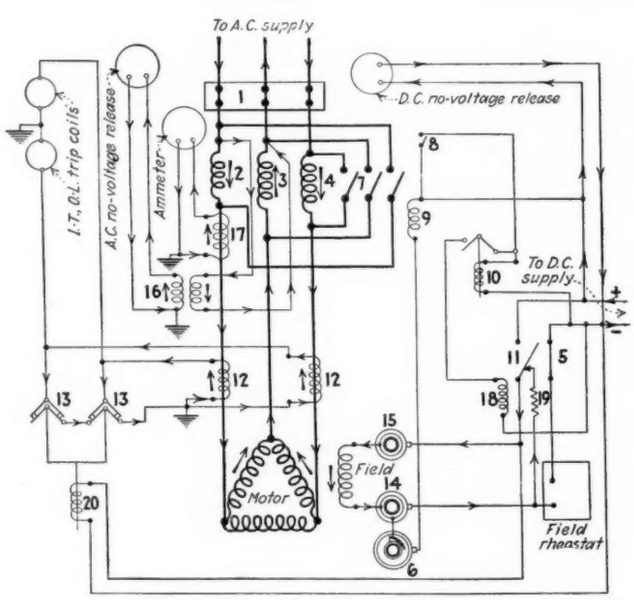


Fig. 2—Starter connections showing circuits when main switch is closed

Diagrams of the starter are shown in Figs. 1 to 4. The equipment is designed with the idea of reducing the human element in starting to a minimum. The motor field switch is made up of a single-pole knife switch 5, for one side and a magnetically operated clapper-type switch 11 for the other side of the circuit. To start the motor, the operator closes oil switch 1, which can be arranged for solenoid operation from a push button if desired. This switch is interlocked mechanically with knife switch 5 on the field, and is interlocked in such a manner that it must be closed when the main switch is closed as in Fig. 2, but it can only be opened manually. With switch 1 closed the stator winding is connected to the line through reactances 2, 3 and 4, with the field circuit closed through the discharge resistance 19, as indicated by the arrowheads. In both these circuits alternating current flows, so that the arrowheads indicate the direction of current at one instant only.

When the motor reaches a predetermined speed, the centrifugal switch in slip ring 6 closes, as in Fig. 3, and completes the circuit through closing coil 9 on switch 7 connected across the reactance coils. The circuit for this coil is from the + side of the direct-current supply through the coil to rings 6 and 14, the field rheostat and to the — side of the line. Energizing coil 9 closes switch 7 as in the figure and applies full voltage to the motor.

When switch 7 closes, it pulls in auxiliary contact 8 which completes the circuit through relay coil 10, which can be adjusted to close field switch 11 after a definite period, as indicated in Fig. 4. Closing of the field switch will bring the motor into synchronism if it has not already pulled in.

During the starting period relay 13 is closed and short-circuits current transformers 12, thus making the overload release inoperative while the motor is coming up to speed. With the closing of field switch 11 a circuit is completed for the coil on relay 13, as indicated, manually, so that there is no danger of the field opening except across the discharge resistance.

If the alternating voltage should be interrupted, the main switch will be tripped out by the no-voltage release. As the machine slows down the slip-ring centrifugal switch opens and interrupts the circuit to the holding coil on the reactance switch 7 and this switch opens, as will also the field switch, and the control comes to normal starting position. Where the control is arranged for automatic starting, provisions can be made so that the motor cannot be started again after a voltage failure until the starting button is pushed, or the control can be arranged for the motor to start again automatically when conditions become normal on the system.

Although no protection is provided to disconnect the motor from the line during starting in case it is subjected to an excessive overload, the reactances are designed to limit the current to a value that will not injure the motor even under a prolonged application.

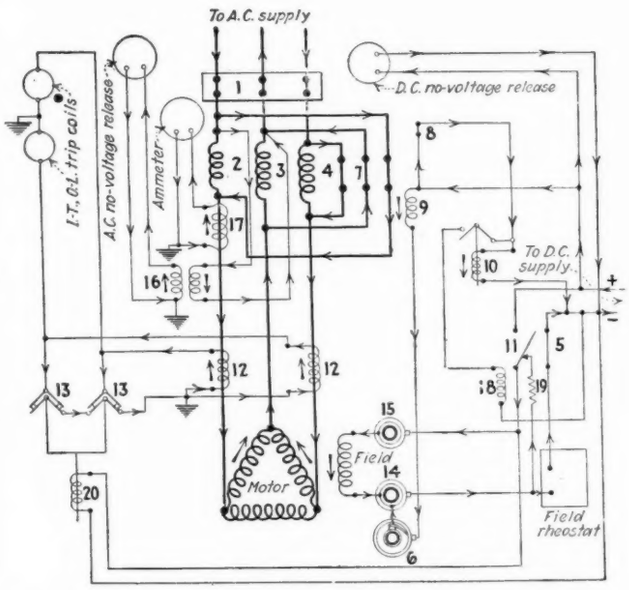


Fig. 3—Circuits through starter after reactance switch closes

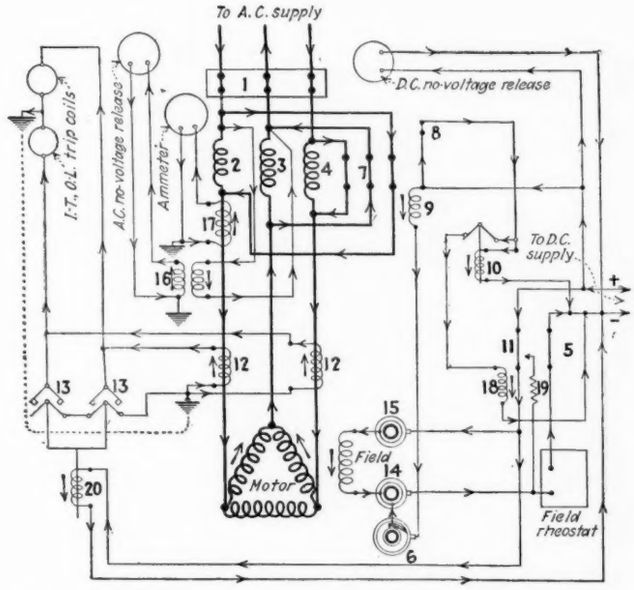


Fig. 4—All circuits through starter shown for normal operation

and holds this relay open, providing overload protection to the motor. By providing this relay with a dashpot, a short interval is permitted to elapse between the closing of the field switch and the removal of the short-circuit on the current transformers to permit the motor to pull into step. This time can be adjusted to a minimum for the motor to come into synchronism. A separate current transformer and ammeter is in one leg of the motor circuit so that an indication of the current taken from the line is available at all times. The main oil switch is equipped with a direct-current no-voltage release and an alternating-current no-voltage release, so that in case of voltage failure on the excitation system or the power circuit the main oil switch will be immediately opened and the motor disconnected from the line. Failure of excitation voltage will also cause all the other switches with the exception of 5 to come to the normal off position, so that the motor will be ready to start as soon as conditions on the exciting system become normal. The single-pole knife switch on one side of the field will not open since it can only be opened

Starting with a reactance in the circuit is somewhat similar to starting with a resistance in circuit, in that as the motor comes up to speed and the current decreases, the voltage across the motor terminals is increased automatically, so that when the switch closes and short-circuits the reactors, the change in voltage is probably less than when a compensator is used. Furthermore, the change from part to full voltage is made without interrupting the motor circuit. Consequently, the second starting current peak will be much less than when starting with a compensator and the motor circuit is open during the transition period between tap to full voltage. There is, however, the same objection to a reactor for starting as for a resistance in that the line current is the same value as the motor current.

The cost of producing bituminous coal ("soft" coal) in the United States is about one-third the cost of producing the same class of coal in Great Britain. Yet the American miner earns a higher wage than the British miner.

M.I.T. Investigates Pressure-Volume-Temperature Relation of Steam

By P. W. SWAIN*

AT THE Massachusetts Institute of Technology apparatus has been perfected for determining the volume of water at various temperatures and the relation between pressure, temperature and volume of saturated and superheated steam. The work is under the immediate direction of Prof. F. G. Keyes, who is assisted by Drs. R. S. Taylor and L. B. Smith. The bomb containing the steam or water to be tested is made of pure nickel to resist chemical action. Volumes are measured by a special plunger and micrometer device. A dead-weight gage is used for pressures.

AS EXPLAINED in the first article[1] of the series, the A.S.M.E. has sponsored an extensive investigation to extend and perfect the data from which steam tables are made. The actual work has been divided up among the Bureau of Standards, the Massachusetts Institute of Technology and the Harvard Engineering School. An article in the Aug. 12 issue described the work being done at the Bureau of Standards, where water is electrically heated and evaporated in a highly refined type of bomb, the purpose being to find the specific heat of water and the latent heat of evaporation at various temperatures. The problem at the Bureau of Standards is a "calorimetric" one; that is to say, it involves the measurement of heat quantities.

The apparatus at the Massachusetts Institute of Technology also includes a bomb, but here the similarity stops. The problem assigned to the M.I.T., one for which it was particularly suited, was the determination of the volume of water at various temperatures under saturation conditions and the relation between the pressure, volume and temperature of saturated and superheated steam. The work is going on in the research laboratory of physical chemistry, directed by Dr. F. G. Keyes, who is also head of the Department of Chemistry. Professor Keyes is assisted in the work by Drs. R. S. Taylor and L. B. Smith, research associates. These two scientists have cooperated in the investigation of the vapor pressures and densities of ether at low temperatures, the thermodynamic properties of methane and nitrogen in connection with the extraction of helium from natural gas, the melting point of ice on the absolute-temperature scale, etc. This is mentioned to indicate their broad background of experience in work of a similar nature.

It is evident that the work being carried on at M.I.T. will give the necessary data for filling out the columns for pressure, temperature, specific volume and specific weight in the tables for saturated and superheated steam. Less obvious, but even more important, is the fact that these determinations can be used in computing other steam-table data, such as total heat, entropy, internal energy, etc. In fact, a complete steam table could be computed from the M.I.T. work alone. The same is true of the work at Harvard, and the specific heats of superheated steam as recently obtained by Dr. Knoblauch, of Munich (Germany). The three together will give a triple check. Still another check will be provided by the direct measurement of the heat of the liquid and total heat at the Bureau of Standards.

*Assistant editor of *Power*. [1]See Aug. 5 issue.

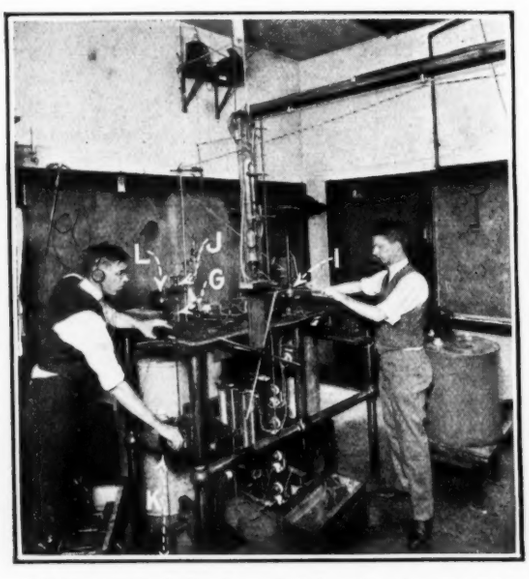


Fig. 1—Dr. Taylor (left) and Dr. Smith operating the M.I.T. apparatus

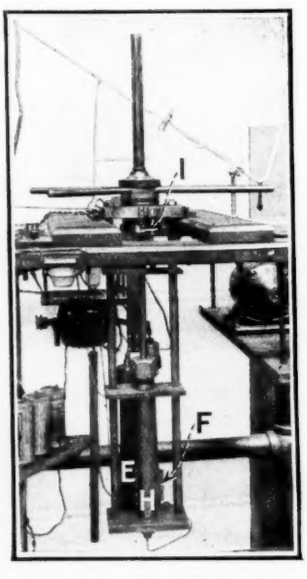


Fig. 2—Micrometer device for the measurment of volumes

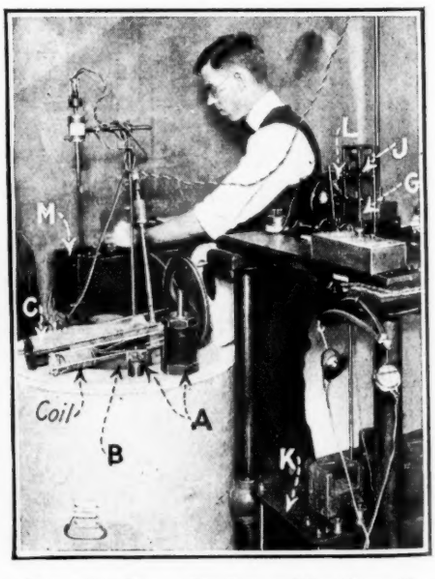


Fig. 3—Dr. Taylor adjusting the "radio-tube" apparatus controlling bath temperature

Fundamentally, the apparatus required for the measurements assigned to M.I.T. is a container or bomb in which a known volume of water or steam can be held at any desired pressure and temperature, some method of measuring the pressure and some method of finding the weight of the fluid in the bomb. The volume divided by the weight gives the desired specific volume of the fluid under the given conditions.

This problem may seem easy, but as a matter of fact it involves many difficulties. Pressure cannot practically be measured in the bomb itself. It must be transmitted to an outside pressure-measuring device. The most accurate known method of measuring pressures is the dead-weight piston gage, such as is used in the dead-weight gage tester with which engineers are familiar. To lubricate the floating piston such a device must be operated with oil.

The next problem is the transmission of the pressure from the bomb to this oil. Water and steam take up oil to a certain extent, so that neither of these can be permitted to come in contact with it. The only liquid that is absolutely unaffected by either oil or water is mercury. Even mercury would tend to vaporize if allowed to come in contact with the hot steam in the bomb. The only solution of this difficulty is to use four fluids, transmitting the pressure of the steam in the bomb first to water, from water to mercury, and from the mercury to oil.

In order to correct the pressure, as measured at the floating plunger of the dead-weight tester, for the "heads" of these various fluids, the location of each of the dividing surfaces (steam-water, water-mercury and mercury-oil) must be accurately known.

The next big problem is to determine the actual weight of steam in the bomb. The total weight of water and steam, including that in the connecting tube, can be found by simply weighing the total amount of water introduced at the start of the experiment. It is then necessary to determine exactly what part of this total is liquid, so that the weight of steam can be found by taking the difference. Since in these tests, and particularly at the lower pressures where steam is very light, most of the water will be in liquid form, it is evident that measurement of the total weight of fluid, and of the liquid portion, must be made with extreme care if the difference is not to have an error exceeding one-tenth of one per cent.

A third difficulty arises in finding the exact volume of steam in the bomb. The most accurate method of finding the volume of a small container is to weigh the amount of mercury required to fill it, the density of mercury being known to one part in 20,000. An unlined steel bomb has been used by some experimenters, but this introduces an error due to the fact that steam attacks steel at high pressures and temperatures. To avoid this, consideration was given to bombs lined with gold or platinum. Such linings, however, have several disadvantages. In the first place mercury attacks both gold and platinum, so that mercury could not be used to measure the volume. Secondly, such linings, being thin, would have a tendency to flow and expand under pressures. Finally, different coefficients of expansion would prevent the lining and the bomb from expanding and contracting together with changes of temperature.

In view of these and other objections to solid steel and lined bombs, it was decided to use a bomb bored out of a pure nickel forging. With the co-operation of the International Nickel Co., one experimental nickel bomb has already been constructed and a second is nearing completion, the first bomb having developed a flaw. Incidentally, it may be mentioned that all parts of the apparatus in contact with steam or water are

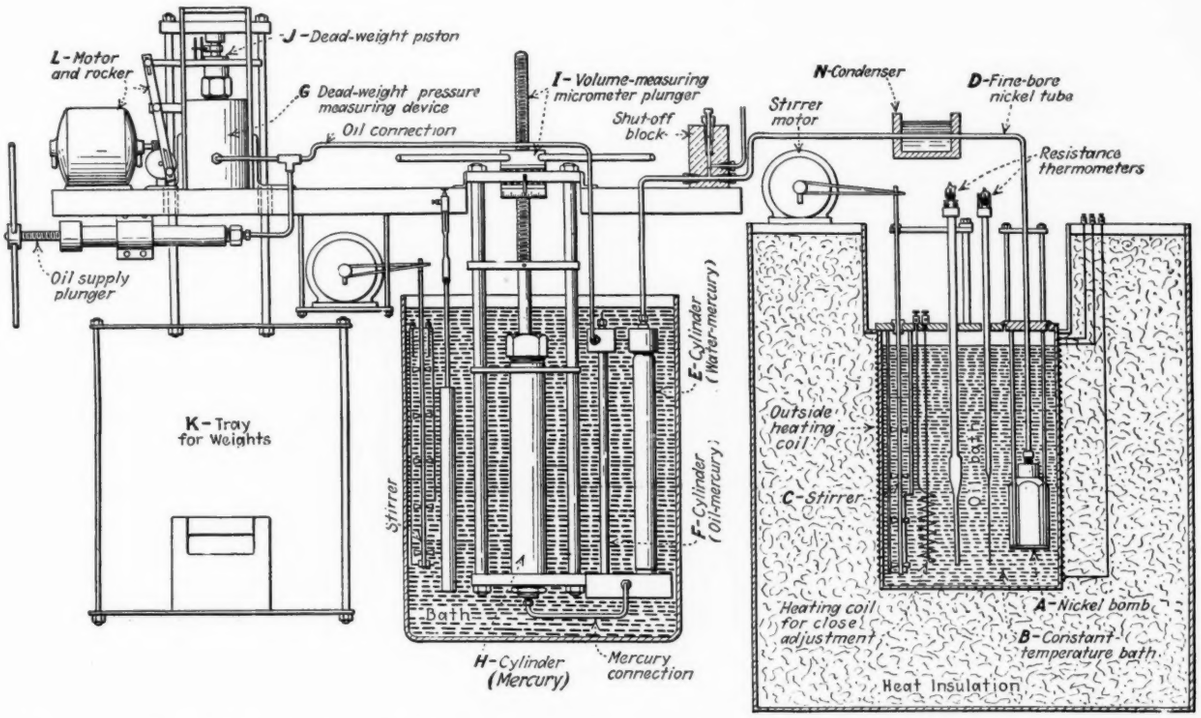


Fig. 4—Cross-section of apparatus, showing method of controlling temperature and of measuring temperatures, volumes and pressures

made of pure nickel. The experimenters have gone to considerable trouble to get the necessary nickel and construct the parts. Fig. 5 shows the second bomb being bored out from a solid nickel forging.

Photographs of the actual apparatus are shown in Figs. 1, 2 and 3 and a simplified diagram in Fig. 4. Referring to any of these figures, *A* is the nickel bomb holding about 25 cu.in. and having walls $\frac{3}{8}$ in. thick. This is immersed in the constant-temperature oil bath *B* electrically heated and automatically regulated to keep the temperature constant within $\frac{1}{10}$ deg. F.

To maintain uniform conditions the oil is continually circulated by the stirrer *C*. For high temperatures, where oil would be unsuitable, a mixture of sodium and

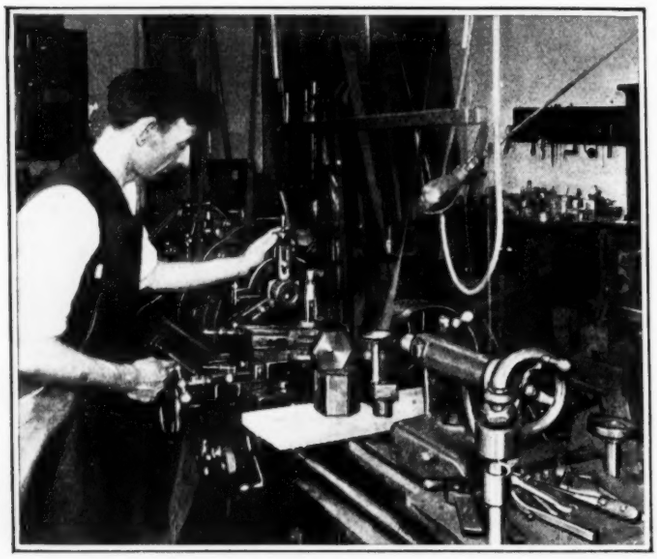


Fig. 5—Boring the second bomb out of a solid nickel forging (original bomb resting on board)

potassium nitrates is used for the bath. This melts at about 490 deg. F., and can be used satisfactorily up to 1,500 deg. F. Attached to the top of the bomb by a special forced-fit cone type of union is a nickel tube *D* having an outside diameter of 0.090 in. and a bore of 0.02 in. This small bore, necessary to keep down errors due to uncertainties in the location of the boundary between steam and water in the tube *D*, was obtained only with great difficulty and by joining short lengths. This tube connects to the volume-measuring device at the top of the nickel cylinder *E*, the bottom half of which contains mercury. The arm *F*, connected to *E* at the bottom, is likewise filled with mercury at the bottom. Above this is oil, which continues over into the pressure gage *G*. There is also a third arm *H* containing mercury, and a displacement piston operated by a calibrated screw *I*. This arm is, in effect, a micrometer for changing the mass of steam in the bomb.

The plunger *J* of the dead-weight tester is loaded by weights placed in the pan *K*, and is given an alternating twisting motion by the motor and rocker *L*. This is done to avoid sticking.

The bomb having been loaded with a definite weight of water for a series of tests, the bath is brought up to the desired temperature, where it is maintained by a special thermostatic control which makes use of the vacuum tube, well known to the radio enthusiast. This device is shown at *M* in Fig. 3.

The temperature of the bath is measured by means of a platinum resistance thermometer sensitive to 0.005 deg. F. and probably accurate to at least 0.04 deg. F.

A water condenser *N* on the nickel tube *D* forms a fairly definite line of demarcation between the steam on the bomb side and the water on the side leading to the oil cylinder *E*. In computing the volume of the steam, allowance must be made for the volume of the tube up to this point, and for the slight enlargement of the bomb due to increased pressures and temperatures. The mass of steam in the bomb is adjusted to any desired volume by means of the micrometer screw device *I*, and weights placed on the scale pan until an electrical contact device indicates that the mercury-oil surface in *F* is at a predetermined fixed point. When this balance has been made, the reading of the micrometer screw shows what part of the total volume of water exists as steam in the bomb (including the tube up to the condenser).

Assuming these measurements to have been made, four quantities are now known for the steam: Total weight, total volume, temperature and pressure. Dividing the volume by the weight gives the desired specific volume for the given temperature and pressure.

As has already been stated, the specific volumes as determined by the M.I.T. experiments will be valuable not only for direct insertion as such in the steam tables, but also for calculating other steam-table data. In fact, any one of these three investigations (Bureau of Standards, M.I.T. or Harvard) would, with a small amount of additional data, suffice for a complete steam table. The three together will give a triple check.

The chief difficulties of investigations of this kind occur in the preliminary work of studying the problem, and designing, constructing and testing the apparatus. It is necessary for the investigators to be very versatile. They must not only be physicists, chemists and mathematicians, but they must also be adept at glass blowing, welding, metal working and other mechanical operations. The greatest care must be taken so to plan and construct each element that the accumulation of all errors shall not exceed the allowable limit.

The apparatus is now approaching its final stage. With the preliminary work out of the way actual measurements of steam and water volumes should be a relatively simple matter.

The next and concluding article of this series will describe the work being done by Professor Davis and Dr. Kleinschmidt at Harvard, where extremely accurate measurements are being made of the Joule-Thomson effect; that is the drop of temperature of superheated steam when throttled without loss or addition of heat.

Elasticity, according to *The Leather Belting Foundation*, is the direct cause of belt creep, so that the more elastic or stretchy the belt material the more creep obtained. All materials have this property of elasticity so it is impossible to manufacture a belt that will not creep. Furthermore, it is impossible to reduce or eliminate creep by the use of special pulley coverings or belt to carry higher loads than formerly. Under normal conditions the loss due to creep will probably not exceed 1.5 per cent, and is offset by the manifest advantages of an elastic medium between the prime mover, or driver, and the point where the power is used.

Heat Loss Due to Sensible Heat in Boiler Refuse

By E. OGUR
Industrial Plant Equipment Engineer, New York City

IT IS customary in boiler tests and other investigations involving heat generation, conservation and distribution, to make a "heat balance," both numerically and graphically. Its object is to account for all the heat units involved and determine where improvements are possible and practicable.

The heat balance is usually carried out in great detail, practically all accountable losses, however small,

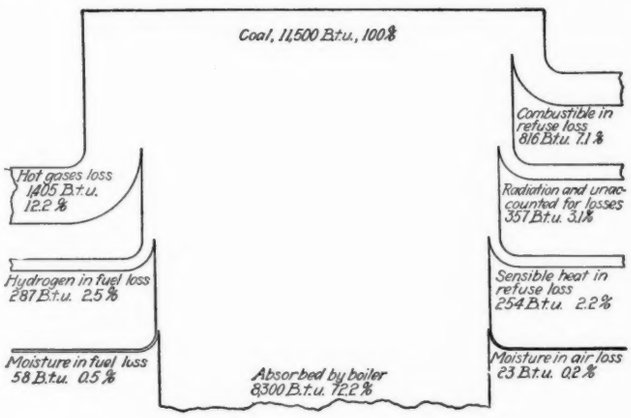

Coal, 11,500 B.t.u., 100%
Combustible in refuse loss 816 B.t.u. 7.1%
Hot gases loss 1405 B.t.u. 12.2%
Radiation and unaccounted for losses 357 B.t.u. 3.1%
Hydrogen in fuel loss 287 B.t.u. 2.5%
Sensible heat in refuse loss 254 B.t.u. 2.2%
Moisture in fuel loss 58 B.t.u. 0.5%
Absorbed by boiler 8,300 B.t.u. 72.2%
Moisture in air loss 23 B.t.u. 0.2%

Fig. 1—Typical heat balance of boiler

being included. Thus, the losses due to presence of CO, moisture in the air, moisture in the fuel, etc., which run between ¼ and ½ per cent, are shown.

Notwithstanding the detail with which the heat balance is made, the loss due to the sensible heat in the refuse is not ordinarily accounted for. Some authorities state that it is less than ½ per cent, others say that it is negligibly small.

Neither of these statements is correct. The loss due to sensible heat in the refuse is fourth in magnitude

TABLE I—COMPOSITION OF CARBON-FREE ASH, ANTHRACITE COAL

Compound	Per Cent
SiO_2	56.00
Al_2O_3	33.30
Fe_2O_3	5.00
CaO	1.00
MgO	1.00
Na_2O	0.70
K_2O	3.00
	100.00

of the accountable losses and third in magnitude of the controllable losses, as Fig. 1 shows. This loss may be as high as 4.5 per cent, and fully half of it is preventable.

The amount of heat carried away by the hot refuse is determined with no greater difficulty than any other item in a boiler test. It may be determined by direct measurements, or it may be approximated with a fair degree of accuracy, from the amount of the refuse, its composition and the specific heat of the different substances composing the refuse.

If the former method is to be used, an ash barrel is covered with 85 per cent magnesia, 1½ in. thick, and half filled with water. A representative amount of hot refuse is thrown into the water and the rise in temperature noted. The B.t.u. loss per pound of dry coal fired, due to the sensible heat in the refuse is computed by means of the formula;[1]

$$\text{Sensible heat loss} = \frac{(W + ws)t}{W^1} \times \frac{P.C.}{100}$$

where w = weight of the metal portion of the ash barrel, s = its specific heat, W = weight of the water in the ash barrel, W^1 = weight of the ash thrown into

TABLE II—COMPOSITION OF THE REFUSE PER POUND OF DRY COAL FIRED

Composition	Pounds
Carbon	0.0500
SiO_2	0.0840
Al_2O_3	0.0500
Fe_2O_3	0.0075
CaO	0.0015
MgO	0.0015
Na_2O	0.0010
K_2O	0.0045
	0.2000

the water, t = temperature rise, deg. F. and $P.C.$ = per cent refuse (of dry coal fired).

For all practical purposes the second method—that is, approximation from the known composition of the

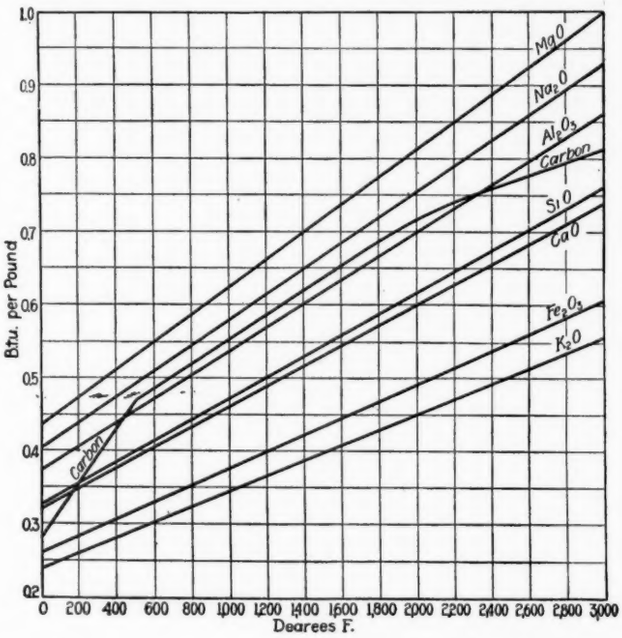


Fig. 2—Specific heat of compounds found in refuse

refuse—will suffice. To illustrate the method let us consider a concrete case of the refuse of anthracite coal containing 15 per cent ash. The refuse, let us assume, constitutes 20 per cent of the total amount of dry coal fired; that is, it contains 25 per cent carbon.

According to the United States Bureau of Mines (Bulletin 129) the average composition of carbon-free ash from anthracite coal is as given in Table I.

[1]This formula is not absolutely correct, but it accounts for 98 per cent of the heat loss due to the sensible heat in the refuse.

The refuse per pound of dry coal fired, in the case under consideration, will be as shown in Table II, where the carbon is obviously 0.05 lb. and the other quantities are 0.0015 times those given in Table I.

The specific heat of the various compounds found in the refuse is shown in Fig. 2. The curves have been computed by means of the formulas given in Richardson's "Metallurgical Computations." From these curves the mean specific heat and the B.t.u. absorbed by a pound of each substance when its temperature is raised from the room temperature of about 75 deg. to the temperature of the refuse leaving the furnace, which is about 2,400 deg., is as shown in Table III.

The B.t.u. loss per pound of dry coal fired, due to sensible heat in the refuse is determined by combining Tables II and III, as shown in Table IV.

TABLE III—HEAT ABSORBED PER POUND IN 2,300 DEG. TEMPERATURE RISE

Compound	Mean Specific Heat	B.t.u. Absorbed
Carbon	0.572	1,315
SiO_2	0.550	1,265
Al_2O_3	0.582	1,340
Fe_2O_3	0.406	934
CaO	0.494	1,135
MgO	0.670	1,540
Na_2O	0.620	1,426
K_2O	0.370	850

Assuming that the coal under consideration has a heat value of 11,500 B.t.u., the loss due to sensible heat in the refuse is $\frac{255.2 \times 100}{11{,}500} = 2.22$ per cent.

In the foregoing case a very favorable boiler performance yielding an efficiency of over 72.0 per cent has been assumed. Coal containing 25 per cent ash is not unheard of, and in average stoker practice 35 per cent combustible in the refuse is frequently met with. Under those conditions the total refuse is about 38 per cent of the coal fed into the boiler furnace and the loss due to the sensible heat in the refuse will reach from 4 to 4.5 per cent.

TABLE IV—TOTAL HEAT LOSS

Compound	Computation	B.t.u. Loss
Carbon	1,315 × 0.050	65.7
SiO_2	1,265 × 0.084	106.3
Al_2O_3	1,340 × 0.050	67.0
Fe_2O_3	934 × 0.0075	7.0
CaO	1,135 × 0.0015	1.7
MgO	1,540 × 0.0015	2.3
Na_2O	1,426 × 0.0010	1.4
K_2O	850 × 0.0045	3.8
Total		255.2 B.t.u. loss per pound of dry coal fired.

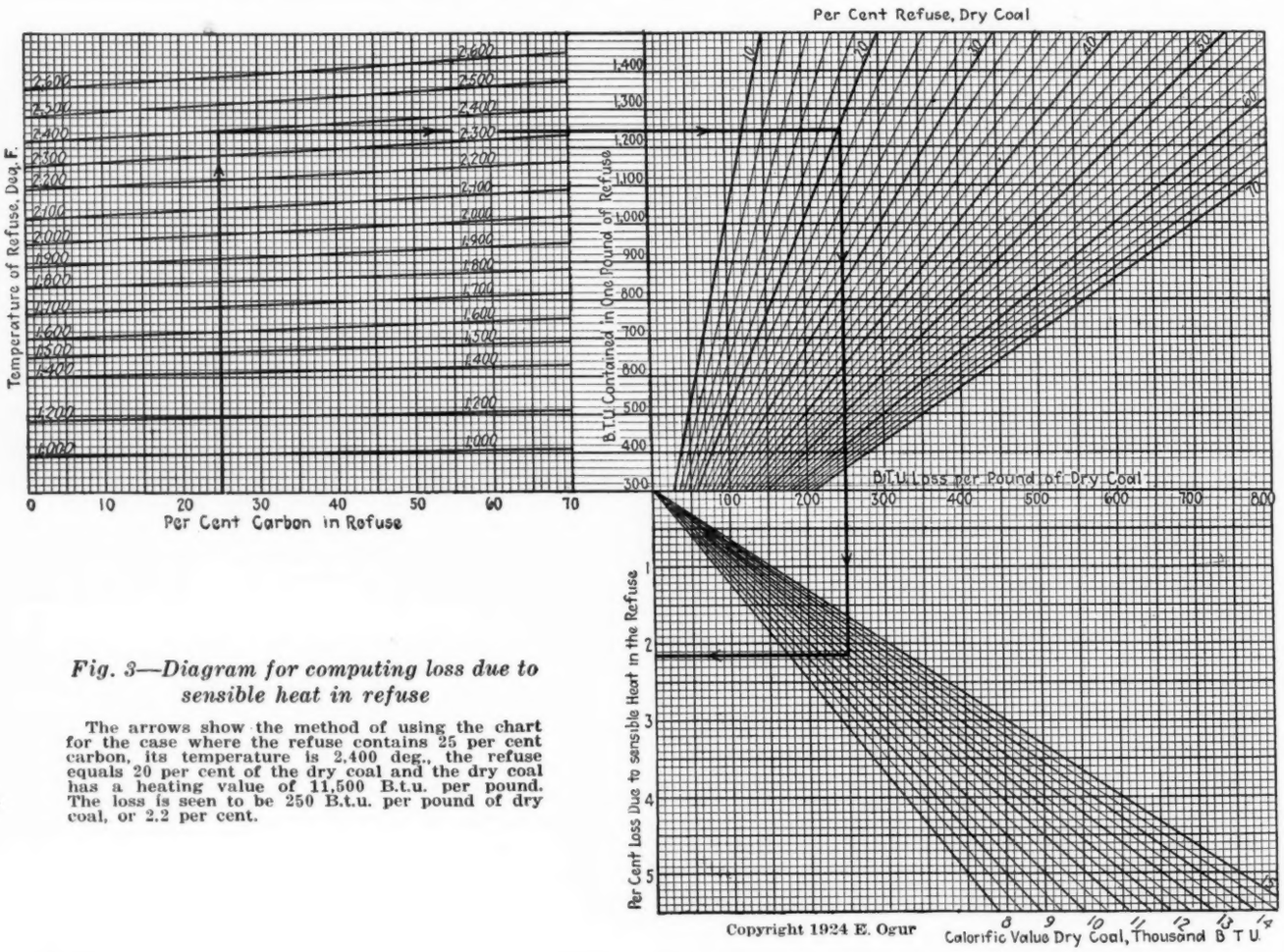

Per Cent Refuse, Dry Coal
Temperature of Refuse, Deg. F.
Per Cent Carbon in Refuse
B.T.U. Contained in One Pound of Refuse
B.T.U. Loss per Pound of Dry Coal
Per Cent Loss Due to sensible Heat in the Refuse
Calorific Value Dry Coal, Thousand B T U
Copyright 1924 E. Ogur

Fig. 3—Diagram for computing loss due to sensible heat in refuse

The arrows show the method of using the chart for the case where the refuse contains 25 per cent carbon, its temperature is 2,400 deg., the refuse equals 20 per cent of the dry coal and the dry coal has a heating value of 11,500 B.t.u. per pound. The loss is seen to be 250 B.t.u. per pound of dry coal, or 2.2 per cent.

As in the case of other losses it is impossible or impracticable to reduce the losses beyond a certain limit. It is impossible to get ash-free coal, and it is impracticable to reduce the temperature of the refuse to less than 1,800 deg. F. or to burn out all the carbon in it, on account of the limitations in the length of time the fuel may remain in the furnace.

It is therefore evident that the loss due to the sensible heat in the refuse is not a negligible quantity. Under the most favorable conditions it is not less than 1.5 per cent. It is a function of ash in the coal, the combustible in the refuse and the temperature at which the refuse leaves the furnace. High ash is, therefore,

to be looked upon not only as a dead weight to be carried to the furnace, through the furnace and to the dumping ground, but also as a medium that reduces the B.t.u. available for steam generation. Likewise, the presence of combustible in the refuse represents not only a loss in itself, as unconsumed carbon, but it also carries a considerable quantity of sensible heat into the refuse.

The evaluation of this loss by the method just given is somewhat laborious. An accuracy of 5 per cent, corresponding to an accuracy of about 0.1 per cent in the final results, is all that is required in this work. The chart, Fig. 3, gives this loss at a glance when the factors determining that loss are known. The percentage of refuse and the percentage of carbon in the refuse are usually determined in any boiler trial, and the only additional measurement required is the temperature of the refuse, which can be easily measured by means of a suitable pyrometer. The chart is easy to handle and gives results accurate to 2 per cent or better.

Generally, it will be found that all the three factors affecting the loss due to sensible heat in the refuse increase as the time the fuel remains in the furnace decreases.

Consequently, the loss due to sensible heat in the refuse increases rapidly with the steaming rate. This partly accounts for the reduced efficiency and economy at steaming capacities around 150 to 175 per cent of the normal rating of the boiler.

Comparison of Four-Valve and Two-Valve Unaflow Engines

BY MARSHALL L. BARKER

Much has been written, from purely theoretical reasoning, as to the relative merits of the two-valve and four-valve unaflow engine. Unfortunately, it has been more or less impossible to cite a series of tests to substantiate the theoretical conclusions.

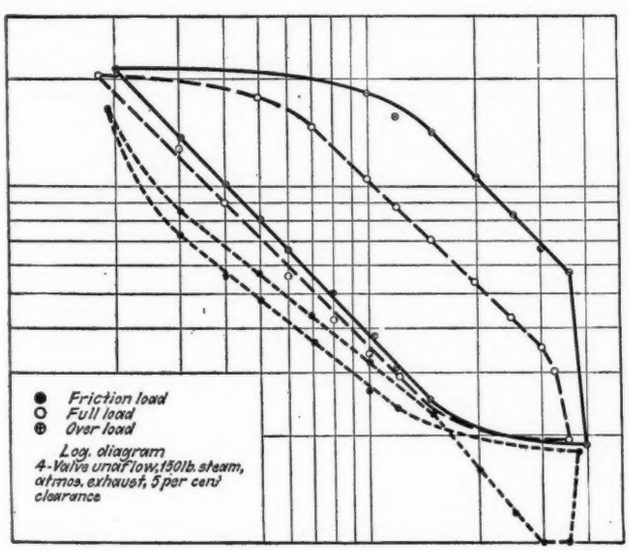


Fig. 1—Logarithmic diagram of a four-valve unaflow

Recently, extensive tests were run upon a four-valve unaflow engine with steam-jacketed heads, the steam pressure being 150 lb. gage, the exhaust atmospheric and the clearance approximately 5 per cent. The steam was weighed after being condensed in a surface condenser, the condenser pressure being atmospheric. No correction was made for the moisture in the steam, which however, was practically dry.

Typical indicator diagrams taken during the test were plotted on logarithmic paper, and are reproduced

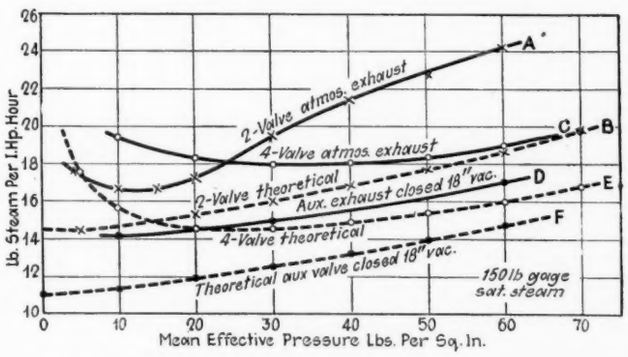


Fig. 2—Steam consumption of two and four-valve unaflow engines

in Fig. 1. The slope of the expansion is uniform for the three load conditions shown, although the slope is less steep at friction load. The steam consumptions at various loads are shown in Fig. 2 by the heavy line curve marked "4-valve, atmos. exhaust." The similarity in shape of this curve and the theoretical curve for an ideal four-valve unaflow is illustrated by the curves *C* and *E*, Fig. 2. On light loads the curve for the actual engine is nearer straight than is the theoretical steam consumption line. The lowest point on both curves comes at the mean effective pressures reached by expansion to atmospheric pressure.

Immediately after these tests were run, the auxiliary exhaust valves were removed and large clearance cham-

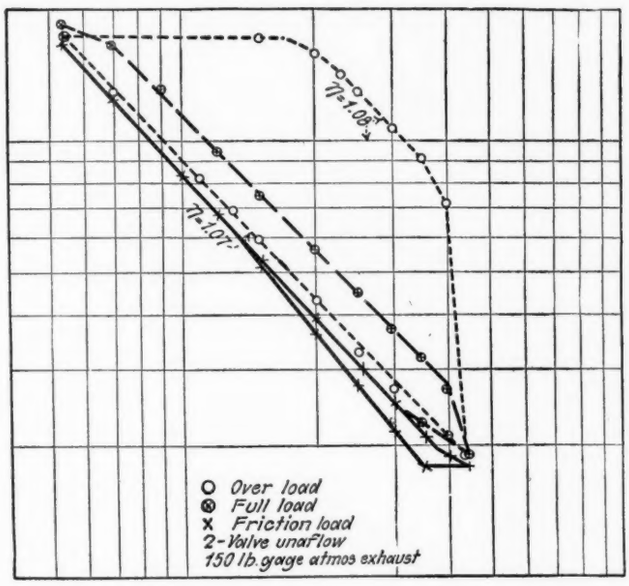


Fig. 3—Two-valve unaflow logarithmic diagrams

bers inserted, bringing the clearance to 14 per cent. The clearance chambers were jacketed by the exhaust, by reason of the piping connections.

Tests were run at 150 lb. saturated steam pressure and with atmospheric exhaust. The steam consumptions

plotted against the mean effective pressures are given by curve *A*, marked "2-valve, atmos. exhaust." Curve *B* shows the results to be expected from a perfect 2-valve unaflow.

The difference in the shape of the two-valve and four-valve curvatures is noticeable. If a two-valve engine is to give as good results as the four-valve machine, the cylinder should be larger, which means a greater friction load and a greater cost. However, the lowest fuel consumption of the actual two-valve engine is below the lowest point on the actual four-valve engine curve, but the mean effective pressure is about one-third that given by the four-valve at its most economical steam consumption. In other words, it seems as though for non-condensing operation the clearance does not greatly influence the engine's best economy, but does shift the value of the mean effective pressure.

It will be observed from Fig. 3 that expansion and compression lines of the two-valve indicator diagrams, when transferred to logarithmic paper practically agree with the adiabatic up to the overload condition, but are quite different from the behavior of the four-valve engine. This indicates that there is some variation in the thermal action in the cylinder when operating as a two- and as a four-valve unit.

This statement is given additional weight by tests run with the auxiliary valves closed, but with the engine operating under 18 in. vacuum. The results appear as curve *D* in Fig. 2 and are plotted on logarithmic paper

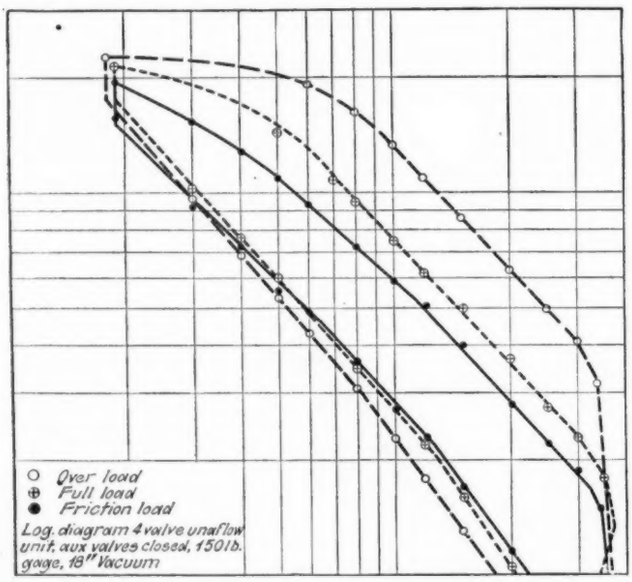


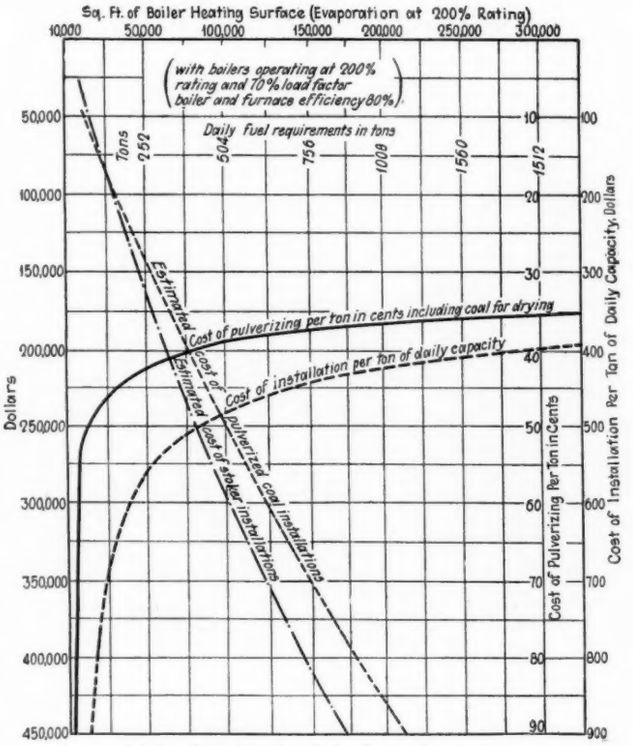
Fig. 4—Logarithmic diagram obtained with two-valve condensing engine

in Fig. 4, which should be compared with the theoretical curve *F*. All these tests were run on the same engine by the same men inside a period of two months; the same indicator was used in all tests.

It is the purpose of Bulletin 139, issued by the Engineering Experiment Station, University of Illinois, to investigate the conditions of equilibrium, to establish the necessary equilibrium equations and to incorporate these equations into a formulation by means of which the maximum temperature resulting from the combustion of a fuel under predetermined conditions may be calculated.—*Chemical and Metallurgical Engineering.*

Cost of Pulverized Installations

Engineers who are interested in pulverized-coal systems will find the accompanying chart a great help in estimating the approximate cost of such a system. This was prepared from data given at the First World's



Cost of pulverized-fuel equipment

Power Conference by a builder of pulverizing systems. While applying to that particular make of equipment, it is fairly representative of the cost of any standard machinery. It appears from the chart that the installation and operating costs in plants of under 200 tons make the centralized system less attractive than is the case when a large tonnage is burned.

The curves showing the installation costs of pulverized fuel and of stoker equipment are intended to cover all items entering into the systems. The stoker curve embraces the costs of bunkers, conveyors, crushers, ash disposal, etc. The chart indicates that stokers cost more than pulverized coal equipment for boiler plants having over 25,000 sq.ft. of heating surface, although supporting data were not given.

Reconstruction of Blast-Furnace Blowing Engines

BY W. BENEDICT*

The "Rheinischen Stahlwerke," one of the most important German metallurgical concerns, have in their works at Duisburg-Meiderich, six 3,200-hp. twin blowing engines, five of these machines having been supplied in 1905 and 1908 by the Maschinenfabrik Augsburg-Nürnberg. As the Rheinischen Stahlwerke intended to increase the output of their blast furnaces, it was necessary to raise the capacity of the blowing engines. The air-valve gearing on these engines, being a Corliss gearing with four rotary slide valves at each cylinder,

*Mechanical Engineer, Duisburg, Germany.

did not permit an increase in the speed beyond 75 r.p.m. As the administration of the blast-furnace plant considered the simple and safe plate-spring valve to be adaptable for this reconstruction work, this type was substituted for the old arrangement.

Fig. 1 shows one of the blowing engines before the reconstruction. The four rotary slide valves are actuated by a wristplate driven by a reach rod and gear from the crankshaft. This valve gearing consumed much power, apart from the large consumption of oil. Besides the two suction and distributing slide valves, each cylinder has ten heavy check valves in each pressure casing. For the reconstruction, all the distributing slide valves with drive were removed, and long extended plate spring valves fitted into the slide valve casing. An overflow, or safety valve, which was located in every cylinder cover and opened toward the suction chamber, was altered into a round suction valve, the arrangement being shown in Fig. 3.

The valve seats are illustrated in Fig. 2 and, as will be noted, are simple and inexpensive in construction.

Apart from the considerable simplifying of the air-valve gearing which was attained, as will be seen from Fig. 4, the machine has also been much improved in its purely exterior design. Through the reconstruction of the blower, the number of revolutions, which before the alteration was not allowed to exceed 75 per min., was increased to 95; the suction capacity was therefore increased in the same proportion. The management of the blowing-engine central station had calculated that the 8 air slide valves with their complicated drive, including 32 joints, required 320 hp. In addition to this the compression work has become considerably more favorable, and, further, the consumption of lubricating oil has been greatly reduced. Before the alteration, each blowing engine had 56 lubricating places for oil and 24 for grease, requiring for 24 hours' work about 55 lb. of oil and 35 lb. of grease for lubricating the rotary slide valves and their driving devices. As the "Demag" plate-spring valves require no lubrication, an important saving in lubricating material has resulted.

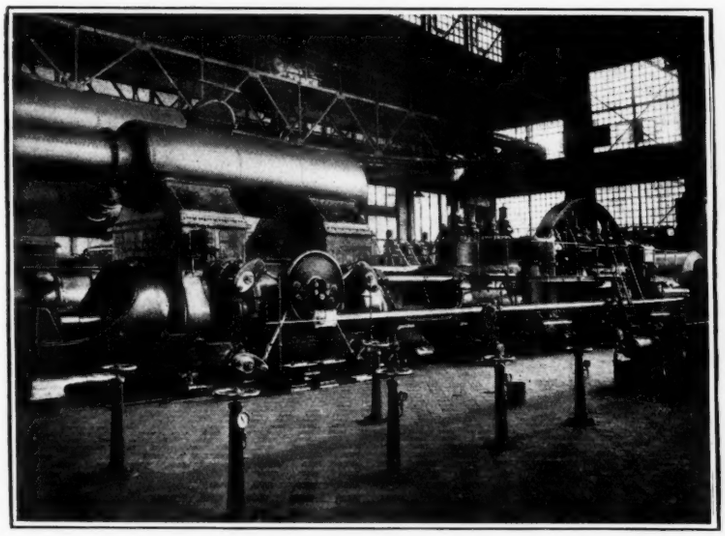


Fig. 1—Showing complicated valve gearing

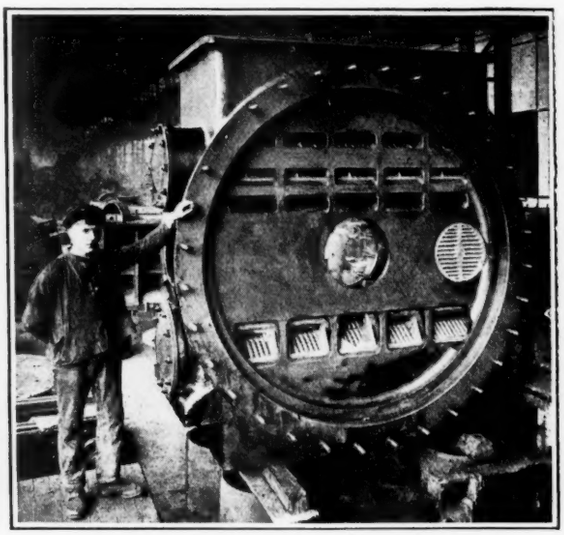


Fig. 3—Spring valves in place

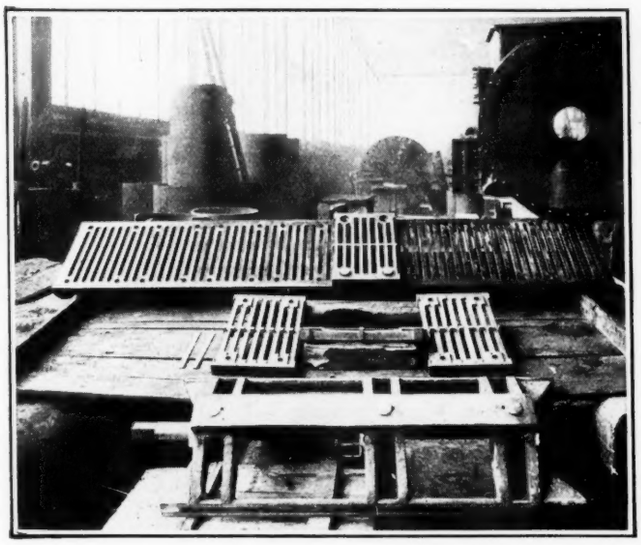


Fig. 2—Seats for spring valves

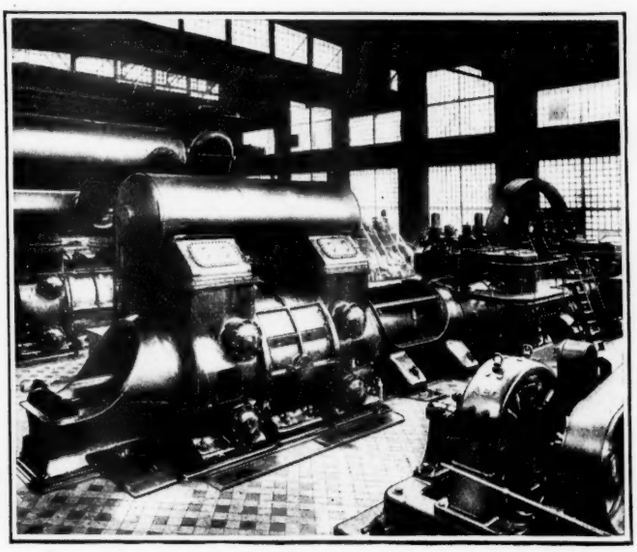
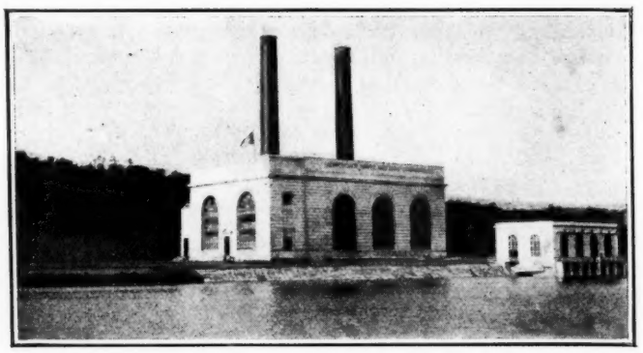


Fig. 4—Engine after gearing was removed

Burning Anthracite in a Modern Steam Plant

By E. E. ROWE



OPERATING records of the Amsterdam, N. Y., Station of the Adirondack Power & Light Corporation show a net kilowatt-hour output on the lines for every 21,000 B.t.u. supplied in the fuel. This means a coal rate of about 1.88 lb. of anthracite per net kilowatt-hour. Since boiler-plant operation has a good deal to do with this unusually low consumption, a description of the furnace design and stoker operation should be of general interest.

Fig. 1 shows a cross-section through the furnace of No. 1 boiler in this plant, being a 13,450 sq.ft. B. & W. boiler, having six longitudinal drums and superheater. The tube bank is 14 tubes high by 42 tubes wide and the setting height is 18 ft. 6 in. above the floor. Two Coxe stokers, each 10 ft. 8⅝ in. wide by 17 ft. long,

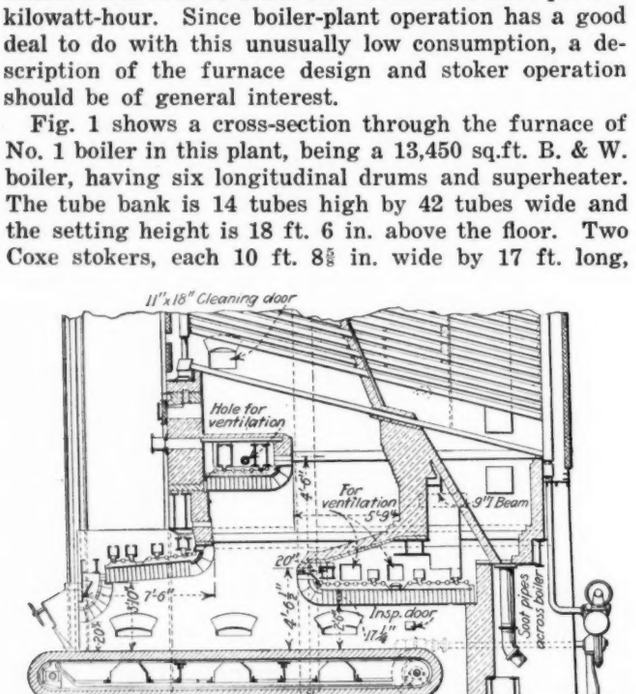


Fig. 1—Cross-section of furnace used

are set under this boiler. The center wall dividing the stokers extends only about 6 ft. above the grate surface, and from this point up to the boiler tubes there is a single furnace which is 14 ft. 5 in. wide. The furnace roof has been formed with flat suspended arches for the purpose of securing complete combustion of gases before the gases reached the boiler tubes. Incidentally, a soot chamber has been located along the rear of the boiler under the second and third passes as shown. There is invariably a quantity of small particles of unburned coal passing through the settings from all anthracite fires. The soot chamber is to some extent a separator to collect these cinders so as to prevent their being thrown out at the top of the stack. The unit has its own forced-draft and induced-draft fan, and there is at present no economizer. Since the total heating surface of the boiler, exclusive of superheater, is 13,450 sq.ft. and the combined area of the two grates is 364.5 sq.ft., the proportion of heating surface to grate surface is about 37 to 1.

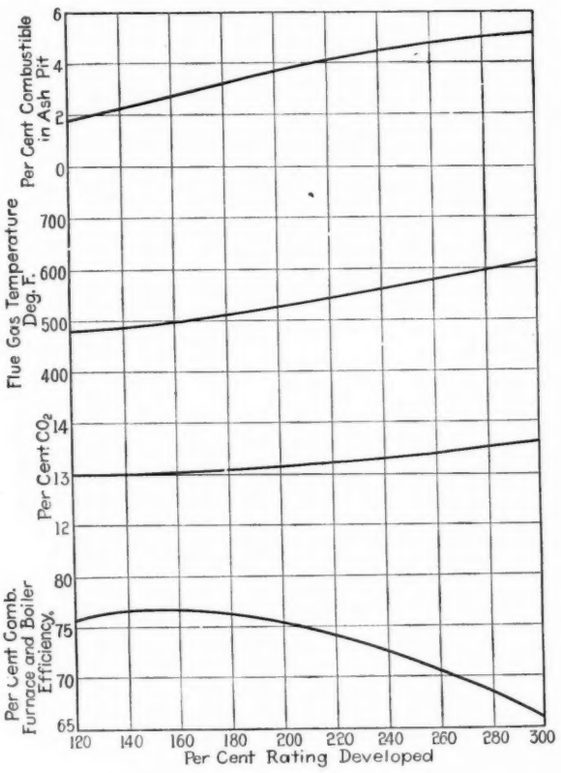

Per Cent Combustible in Ash Pit
Flue Gas Temperature Deg. F.
Per Cent CO_2
Per Cent Comb. Furnace and Boiler Efficiency
Per Cent Rating Developed

Fig. 2—Results of boiler tests

In order to check up daily operation and at the same time to secure positive information regarding various details of performance, a series of boiler tests was run during the summer of 1923. These tests were conducted by the Department of Steam Plants of the Adirondack Power & Light Corporation. Conditions of regular plant operation were adhered to as closely as possible, with the single exception of steady loading. During test runs the stoker speeds were not altered and the rating developed was, therefore, a constant quantity. In regular operation there is more or less fluctuation in the rating developed. The story of what is going on in the boiler room in every-day operation

is therefore fairly well exemplified by these test results. Some fifteen tests were run altogether, six of which were on the No. 1 unit.

No. 3 buckwheat size of anthracite running about 18 per cent ash and 12,200 B.t.u. per lb., dry basis, is the regular fuel for the plant. This was burned at a combustion rate which varied from 19 to 51 lb. of coal per square foot of grate surface per hour. The percentage of rating developed ranged from 134 to 300. It may be remarked that in regular operation with this

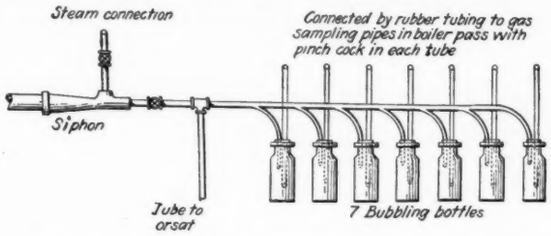

Steam connection
Connected by rubber tubing to gas sampling pipes in boiler pass with pinch cock in each tube
Siphon
Tube to orsat
7 Bubbling bottles

Fig. 3—Method of drawing flue-gas samples

setting over 300 per cent continuous rating has been frequently developed for periods of two to ten hours.

During all test runs the fires were handled according to the experience of the operators in the plant as they are handled in daily operation. It was necessary to cut out the feed-water regulators during tests and regulate the feeding by hand. Since the load on the unit was held steady for the full period of the test, hand regulation was not at all difficult and a steady output line was produced on the steam-flow meters. The temperature of the feed water was practically the same as during all other periods of operation. Fire thickness varied from 4 to 5½ in. and the grate speed varied from 19 to 44 ft. per hour.

All coal was weighed by means of hopper-bottomed boxes set on scales just above the stoker hoppers. The water fed to the boilers was accurately measured in calibrated tanks. It was impossible, however, owing to conditions in the plant, to weigh the ashes from the runs. Fair samples of the ashes were taken and properly quartered down to a laboratory sample which was analyzed to calculate the ashpit loss. The loss by the combustible in the ashpit was quite low, as will be seen by referring to the curves in Fig. 2.

Obtaining Gas Samples

Getting an average sample of flue gas proved to be quite a problem in so wide a setting. As a solution, seven simultaneous samples were taken at equidistant intervals across a 24-ft. 5-in. width of setting. These samples were drawn through water bottles, as illustrated by Fig. 3, in such a way that a fair average of the lot came to the Orsat apparatus. The side-wall influence of the settings was quite marked. The average sample of flue gas ranged from 13 to 13½ per cent CO_2, whereas the highest obtainable sample of flue gas ran very close to 16 per cent on all the runs. There was practically no CO present at the points of the high CO_2. It will be seen at once that in calculating the heat lost by the dry flue gases, the use of the average CO_2 figure would show considerably more loss than the use of the higher figure just mentioned. Whether it is strictly true or not depends of course on the velocity of flue gases at the different points across the setting where the CO_2 readings were taken. In the calculations of these tests it has been assumed that the velocities were equal throughout.

Exit flue temperatures were taken at the same point as the CO_2 readings. The apparatus for this purpose consisted of seven thermocouples made of iron and constantan wire, and these were connected to a Leeds & Northrup potentiometer.

Efficiencies of 70 per cent have been heretofore regarded as excellent operation with anthracite. It will be noted from the efficiency curve in Fig. 2 that this unit developed above 75 per cent efficiency at all ratings up to 200 per cent, the efficiency at 300 per cent rating being around 65 per cent. This performance is due to the combination of the furnace design, a wise selection of a good grade of No. 3 buckwheat anthracite and a high grade of plant operation. This unit is popular with the boiler-room operators since they find it flexible in responding quickly to changing load demands, reaching high ratings with little apparent loss by either the ashpit or the flue.

Average Flue Temperatures

The flue temperatures were well within the average range possible with a boiler of this type, although there are some 20-tube high boilers in the plant that show a consistently lower flue-gas temperature. The flue-gas loss indicated by the CO_2 and temperatures may later be conserved by the use of economizers or air heaters.

Although the record of performance is so high as to be of unusual interest, the Department of Steam Sta-

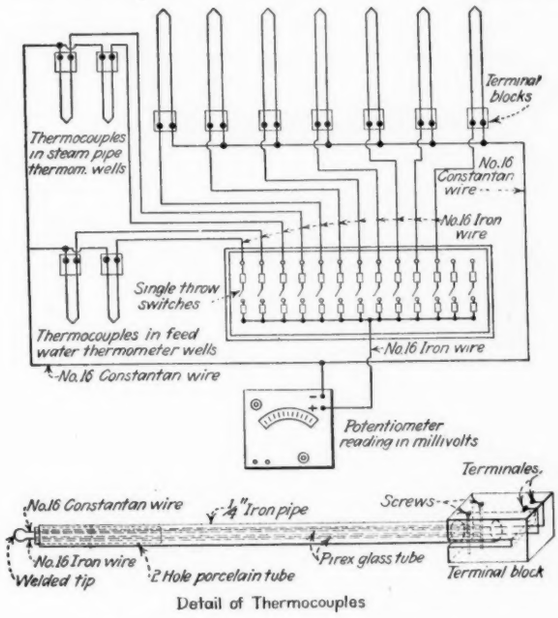


Fig. 4—Wiring for thermocouples

tions regards this boiler setting as but the beginning of its improvement work in burning anthracite efficiently. The furnace is entirely successful so far as producing efficiency is concerned, and does not offer any special difficulties of construction. It has, however, a fault in depositing soot which immediately turns into clinker on top of the rear arch. At around 150 per cent of rating this deposit is unimportant, but at around 250 per cent it becomes so great as to require a shutdown for cleaning about every three weeks. Efforts are, therefore, being directed toward a solution of this difficulty. All this work is being carried on under the direction of W. A. Shoudy, superintendent of steam plants, the stoker, boiler and arch manufacturers lending every possible assistance.

Fig. 4 is a diagrammatic layout of the wiring for the thermocouples. The voltage set up in a circuit of this sort is due to the temperature of the junction of the two metals. It will be noted that while standard copper knife switches were used in the constantan-wire circuits, the constantan wire comes to each switch and leaves each switch. Thus, whatever current is set up by galvanic action on one side of the switch, is exactly counteracted by an equal and opposite current set up at the other terminal, since both terminals are of the same temperature.

The potentiometer has a "cold junction" compensator. The temperature at the instrument is read from a mercury therometer, and a small dial on the instrument is turned to agree to the millivolts represented by the temperature for constantan and iron junction. The millivolts then read from the dial, after adjusting the galvanometer resistance to balance the thermocouple current, is equivalent to the actual temperature at the welded end of the thermocouple in circuit. This is both an accurate and a rapid method.

Temperatures Obtained by Thermocouples

The steam temperature of the boiler mentioned in this report is between 600 and 700 deg. F. Originally, mercury thermometers were used in the wells for reading the temperatures and mercury was used in the wells to conduct the heat to the thermometers, but the mercury vaporized at the temperatures encountered and it was a nuisance to keep the wells full. An additional objection was that the location was away up on the tops of the boilers, at least forty feet from the firing floor. So the test engineers experimented with thermocouples for this, the wells were filled with ordinary solder and the thermocouples immersed in the solder, which was molten at the temperature of the steam. Careful calibration of thermocouples under the same conditions had been made in the laboratory with particularly satisfactory results, and the test engineers found them satisfactory for ordinary use. The result is that the test crew do not have to climb the boilers several times an hour during test, and the readings are more accurate than would be the case if thermometers were used.

A little later the feed-water temperature was taken in the same way, although oil was used in the wells. A careful calibration was made on these thermocouples before they were used during test work and the proper corrections were made in the readings.

Furnace Temperatures

Temperatures in the furnace were observed occasionally with an optical pyrometer. The hotter surfaces of the fuel bed itself were about 2,650 deg. F. The temperature of the incandescent side walls, at their hottest points, was very close to the same figure. In fact no consistent difference was noted.

Every effort was made to get the data accurately and systematically since the purpose was to know what the plant operation actually was; this efficiency with No. 3 buckwheat coal is the best that has been made public. So far as the high results depend upon man power, there is no question that the plant organization will continue to maintain these results. On the score of design, however, it is confidently expected that this first step toward a high efficiency furnace will prove exactly that—a first step, to be followed by others leading to a more economical use of fuel.

The "Minus" Quantity

By William V. Fitzgerald

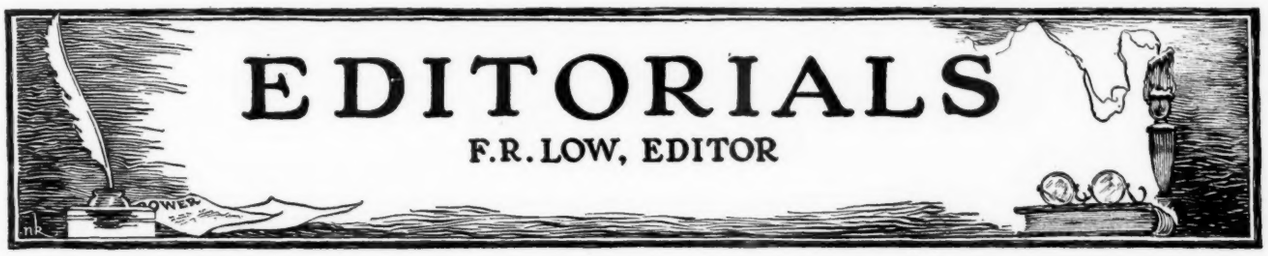
The minus sign in the mathematical world is only a term. But it has a bigger significance than most people think, for its application to the manipulation of numbers and algebraic quantities is not its most important use. Dollars come and go, as do all the things that men spend time calculating with mathematics. The really important use of the minus sign is its application to the *human* equation.

What is a "minus" sign? As applied to making one's way in the world, it is a quantity or quality which one has developed consciously or unconsciously and which is detrimental to success in one's work. A man does not have to go about placarded with posters showing mathematical signs and symbols to display his positive and negative characteristics. However, the average man *does* go about placarded more effectively than any posters could do the job—placarded in so many different ways, insidious ways, that he himself scarcely feels their presence. There are probably as many different kinds of human "minus" signs as there are human beings.

Then there is the fellow who "takes a chance" on something being pretty nearly right, or "just about," or "good enough." What an awful handicap that man carries about in his daily work. He grinds in a valve on his engine and instead of working until the valve and seat are in first-class condition, he concludes it's good enough while there are still pit marks in evidence. He puts his engine together and starts it up only to find that the valves again give trouble in a much shorter time than they ordinarily would. He curses his "rotten luck" and performs the whole operation over again, while men mark him as a man who gets poor results.

A serious "minus quantity" is possessed by the man who has the bad habit of saying he knows when he doesn't know, or of giving some kind of information in the absence of the correct information. This man is a pitfall with a rose garden covering, in any organization. He is the man who will give the explanation of the most profound phenomenon, provided his audience knows nothing of the subject. He has the quick answer and the volume of phrases with which to mystify. He tells you "right off the bat" what the fusing point of cast iron is or what the temperature of steam is at 350 lb. pressure. It takes a little time for associates to get wise to him, but when they do, they usually listen to what he has to say—and promptly consult the handbook or the reference book. This type of man causes a lot of trouble and misunderstanding to others in that sometimes non-technical people who take him seriously become thoroughly convinced of his superior knowledge.

There are two ways to improve one's chances of success. One of those ways is to increase the quantity of factors that are on the positive side of your account—education, experience, interest in up-to-date methods and appliance and other means whereby the number of things one can do well is augmented. The other way to assure success, is to search out the "minus" quantities that have been developed, and to ostracize them rigorously. *Men of talent and brilliance of mind are failures only because they have equally great nullifying characteristics, while mediocre men achieve wonders because they have taken the pains to eradicate their nullifying tendencies.*



Interpreting Cost Data

COST data are always of interest to power plant men, especially those engaged in designing new stations. To accept such data without interpretation, however, may impair their usefulness and lead to erroneous conclusions. This is particularly true of over-all costs reduced to dollars per kilowatt capacity, which are likely to be of little value for comparative purposes unless the basis of computation is clearly set forth and all governing factors given. In fact they may bring embarrassment to the consulting engineer when called upon to explain higher costs in another plant of apparently comparable size, for the man that foots the bills is prone to judge final figures without delving into details.

Site, foundation work, provision for extension, reserve prime mover capacity, size of units and operating conditions that determine the degree of refinement warranted, are among the factors that affect the total cost. Anyone of these may be of sufficient magnitude to render comparison useless.

On the other hand, unit costs applied to individual equipment are always useful to the designing engineer and leave little opportunity for misunderstanding when accompanied by a few particulars as to type, size, etc. Greater dissemination of such information is highly desirable and to this end engineers can co-operate in a spirit of mutual helpfulness, unhampered by the reservations attendant upon over-all costs.

Steam Research a Gilt-edged Investment

IN THIS issue appears the third of a series of articles on the steam research now under way in three leading American scientific institutions. Another article will conclude the series. No thoughtful reader can fail to see that there is a touch of adventure in this work and that the men who carry it on are in some ways akin to those who explore mysterious lands and climb earth's highest peaks. Their reward, like that of most scientific workers, lies largely in the thrill of exploration and the master craftsman's abiding satisfaction in a difficult task well done.

Granting the romance and glamour of this work, the practical engineer is sure to ask: "What good is it; what return will it yield in dollars and cents?" This is a question to which no exact answer is possible. Yet it is a practical certainty that the odd $90,000 which this investigation is expected to cost will yield an enormous return on the investment. The power plants of the United States spend perhaps close to a billion dollars yearly for fuel. Better steam data, particularly at the higher temperatures and pressures where the present tables are far from exact, will certainly produce some fuel saving due to more intelligent design and operation. Expressed as a percentage, this may be small—too small possibly to be apparent directly. To be extremely conservative, let us say that the saving in fuel due to more intelligent design will amount only to one-tenth of one per cent of the national fuel bill for power, an amount too small to detect by comparative tests. Admittedly this saving would not be uniformly distributed throughout the industry; the more scientifically designed and operated plants and particularly the high-pressure plants would be the largest gainers. But, taking one-tenth of one per cent as a conservative average for the whole industry, the total saving would then be one million dollars yearly, a return of over a thousand per cent on the investment. For the investment to yield a paltry one hundred per cent, the national bill for power fuel would only need to be cut one-hundredth of one per cent!

It is hardly conceivable that any intelligent engineer confronted with these figures could deny the practical utility of this investigation. The work deserves the active support of every man interested in the economical production of power, whether he be owner, operating engineer, designer or manufacturer. The financial interest need not be very large to justify such support from purely selfish considerations.

Back to Old Principles of Lubrication

INASMUCH as early lubrication may be regarded as utilizing fairly cool oil at low speeds without the necessity of introducing water, as in bearings supplied by oil cups, rings or gravity tanks, the result of turbine experience indicates that some of these principles have proven superior to the severe conditions of lubrication frequently encountered in such turbines during the early period of manufacture.

The operating engineer of an earlier date would be inclined to look askance at bearings in a small noncondensing machine with the shaft heated above boiling temperature by the exhaust steam, and the oil reservoir showing but a few degrees lower. He would probably be assured that such a new and improved prime mover was inherently different in lubricating requirements. Some of the "old timers" put in water cooling coils on their own account with a result that their judgment, though perhaps derived in a reciprocating engine field, nevertheless was vindicated where speeds were rated in thousands of revolutions per minute.

With the intensely scientific investigations at present on one hand and recorded results of good operation on the other, low oil temperatures have proven their value beyond question. Oil after all is found to be a material of complex structure, which should, for best results receive the benefit of conditions which impose as little physical hardship as possible.

The presence of water in the oiling system is being guarded against due to the active part investigations have shown it to take in producing deterioration. Promiscuous churning and spraying of the lubricant, due

to high speeds in pipes, coupling flanges, or other elements is also to be avoided, on account of the tendency to entrain air and promote oxidation. In some ways lubricating tendencies are distinctly away from those of early turbine design, where novelty or inexperience appeared to warrant as innovations, some features which later proved undesirable.

Don't Let the Boilers Loaf

THOSE who visit industrial power plants cannot fail to compare unfavorably the operating procedure with that of central stations. The isolated plant boilers operated at even normal rating are in the minority, and two hundred per rating is obtained only in those plants where the engineer is progressive.

The boiler room and equipment represents over one-half of the total plant investment. If two hundred per cent rating was carried the overhead charges of the boiler room would be halved, leading to a considerable reduction in the total cost of power.

While hand firing is not conducive to high ratings, most plants of any size are equipped with stokers, and no reason exists for permitting boilers to loaf. The possible objection of increased furnace and tube repairs does not apply until the forcing goes over two hundred per cent rating. In addition moderate overrating tends to an increase in boiler economy and even the small furnace volume so often found would not prevent high economy.

Recent Ventilating Research Involves Large Field

IT IS common knowledge that air currents from an electric fan tend to relieve the discomfort incident to high temperature. Tables that have recently been published as a result of work at the research laboratory of the American Society of Heating and Ventilating Engineers show the effects on the human body of such air currents in terms of effective or apparent temperature. Air temperature, humidity and velocity are the controlling factors. Therefore, from readings of wet and dry bulb thermometers the effective temperature for still air or that moving at a known velocity can readily be found from prepared tables.

The possibilities for ventilating work along these lines can be appreciated from the fact that while every factory is equipped with a heating system, little provision is made for cooling during the summer months, when the greatest physical discomfort and consequent inefficiency is likely to occur. Means for providing effective temperatures suitable to good productive effort may be accurately determined, and a study of some application indicates that the desired results may be obtained at comparatively little expense.

The average summer temperature in one factory was 96 degrees at a humidity that produced an effective temperature of 84.7 degrees in the still air where the men worked, being somewhat higher than desirable. This was reduced to an effective temperature of about 72 by saturating the air and then circulating it at a velocity of 300 ft. per minute. Variations of velocity in different parts of the building, as well as those of clothing worn, tend to change this value. By installing fans to produce the correct air velocity, the effective temperature can often be sufficiently reduced without the use of humidifiers.

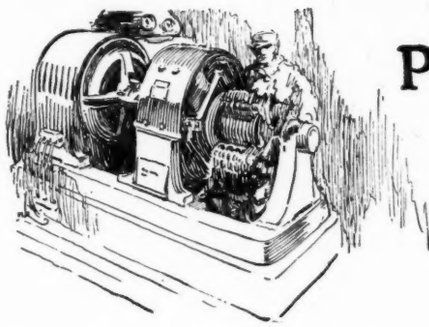
Mines, steel mills, department stores and many other scenes of human activity may prove worth-while opportunities. Each problem presents individual peculiarities. In mines air must be forced for ventilation, while both the humidity and velocity offer means of controlling the effective temperature on the workers, representing a cheaper means, generally, than refrigerating. In steel mills lowering the effective temperature when exposed to radiant heat makes cooling the principal object. Possibility of increased production efficiency makes the engineer's efforts in keeping informed regarding research developments, well worth while.

Protect the Outposts of Hydro-Electric Plants

MANY modern hydro-electric plants are run "wide open" from the standpoint of chance visitors, and there is a potential accident hazard here that should not be overlooked by those responsible for the service. A much greater laxity in regard to letting visitors roam about the premises of such stations usually prevails than can be permitted in steam plants in cities, and doubtless the location of so many water-power installations in remote country districts is the reason for this freedom from restrictions. The ubiquitous motor car is bringing all sorts and conditions of men into hydro-electric plant territories, and it is a question if a little closer supervision of such plants and especially of their outlying pipe lines, surge tanks, racks, gate-houses, valve chambers and dams should not be put into effect.

The problem of power house visitor control, however, is easier to handle in many respects than the protection of what might be called the outposts of installations. One must expect a good deal of free visiting where dams and other headworks are accessible to adjacent highways, and fortunately for the outsider, there is comparatively little personal hazard if he behaves himself. Suitable signs should be posted by the operating company warning against danger where such exists, and an inspection of intakes and forebays should be made to insure all reasonable precaution against accident. Campers should be warned whenever possible before waste gates are opened in such locations as to threaten the safety of small boats which may unwittingly be engaged in peaceful fishing too near the discharge channels from high-powdered reservoirs and canals. Finally, greater care as to locking gate-houses, valves, control switches for valve motor service and local lighting and telephone apparatus deserves the very earnest attention of operators of hydro-electric stations tempted to rely too heavily upon the public's well-intentioned interest in plant property and service.

A new smoke ordinance has recently been submitted to the Common Council of Utica, N. Y., which is advocated by the women of the city. Gradually one at a time, the larger cities of the United States are enacting legislation which will ultimately rid the country of the smoke nuisance. Not only is there an enormous unnecessary expenditure of energy by the housewife in keeping her house clean and livable, extensive damage to materials and merchandise and danger to health in this dense and objectionable smoke but it is a waste of fuel. With better knowledge of combustion and more attention to the firing of furnaces considerable saving in the coal bill and a consequent conservation of fuel would result.



Practical Ideas *from* Practical Men

How To Construct and Use an Armature-Testing Magnet

It is frequently convenient to use a testing magnet, or what is known as a growler, for testing armature faults. In Fig. 1 are given the shape and dimensions for constructing the core for such magnets. The core is built up of thin sheets of iron and held between ⅛-in. brass plate with brass bolts. The holes in these plates should be countersunk and the bolts riveted over after the plates have been tightly drawn together by a clamp or vise. The core may be drawn up tight by bolts in four of the holes, while a clamp may be applied near the fifth when putting in the first rivet. Then the bolts can be taken out one at a time when putting in the other rivets. The core is wound with 60 turns of No. 5 d.-c.-c. wire for operation on 110 volts 60 cycles, and 120 turns of No. 8 wire for use on a 220-volt 60-cycle circuit.

In applying the growler, it is placed against the armature as in Fig. 2. The circuit should not be closed to the magnet coil except when the magnet is in contact with the armature core. Since alternating current is used in the coil, the current may reach a value that will destroy the insulation of the coil if the magnetic circuit is allowed to remain open. The testing magnet may be mounted on a portable truck and arranged with

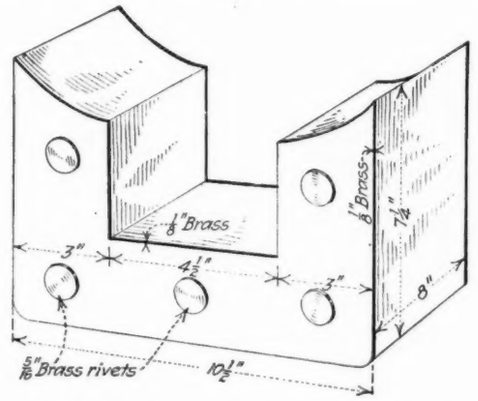


Fig. 1—Core for armature test magnet

counterweights so that the position of the yoke can be varied to suit the position of the armature.

To test for short-circuits, the growler is applied to the armature as in Fig. 2 and the coil energized with 60-cycle alternating current. The pitch of the coils under the poles is determined and the slots one coil pitch away from the area between the poles bridged with a piece of thin steel or iron as indicated in the figure. If this piece of metal has a tendency to vibrate or is attracted to the armature teeth, a coil in the slot bridged is short-circuited.

The principle of this method is that the magnetizing or exciting coil on the growler with an alternating current applied acts as the primary winding of a transformer and the armature coils that lay in the magnetic fields, set up by the two poles of the growler, act as the secondary. Therefore, if a short-circuit occurs be-

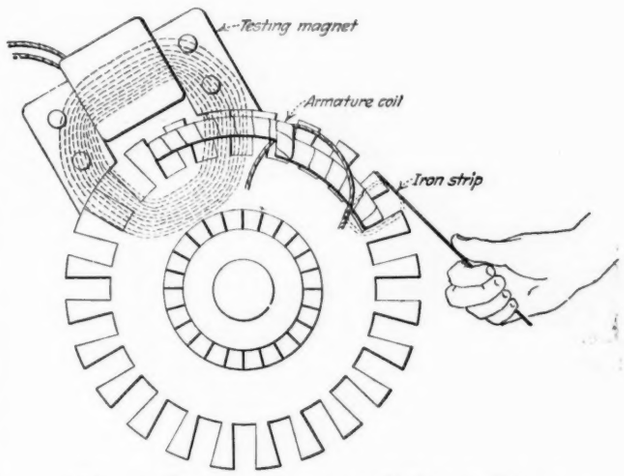
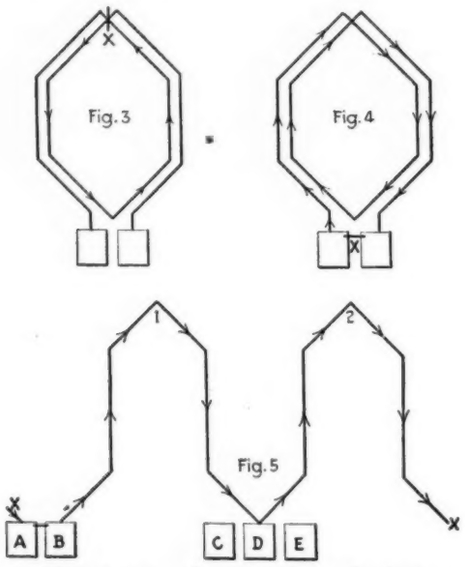


Fig. 2—Testing magnet applied to armature

tween coil turns or commutator bars on the armature, a closed circuit is formed in the coil and a current will flow which in turn will magnetize the teeth adjacent to the faulty coil and will attract a piece of steel. A millivoltmeter can also be used, but for accurate results the bars bridged by the meter must connect to coils that are in the same position under the growler or the growler and meter leads must remain fixed and the armature slowly rotated. A short-circuit in a coil will also cause heating of the coil when it is under the influence of the testing magnet.

Another good feature of the growler is that it will locate and indicate whether a short is in the coil or between bars. For example, in Fig. 3 if the two-turn coil is short-circuited at *X* when the growler is applied, an alternating-current will flow in the circuit indicated by the arrowheads, and the teeth on either side of each coil side will be magnetized and will attract a piece of steel. To determine whether the short-circuit is in the coil or between the commutator bars, take a knife blade or any piece of metal and bridge the two bars to which the coil connects, then break contact with one bar. If a spark occurs at the instant contact is broken, the short is in the coil. The reason for this can be readily seen from a study of Figs. 3 and 4. In Fig. 3, if the two bars are connected together, the two outside turns

will be short-circuited and a current will be set up in these turns and when contact is broken at the commutator, a spark occurs. On the other hand, if the short is between bars, as shown at *X* in Fig. 4, then the complete coil is short-circuited, the circuit being



Figs. 3 to 5—Circuits through short-circuit armature coils

closed by the short at *X*. Bridging the bars at any other point will not effect the circuit, hence no spark will be noticed.

On a four-pole wave winding a short-circuit between two commutator bars will show up in four places on the core, as shown in Fig. 5, since a group of two coils is short-circuited. The best way to make the growler test is to go once around the armature with the feeler and mark each slot with chalk that develops attraction. Then try each short-circuited coil by the make-and-break method at the commutator.

A. C. ROE, Repair Superintendent,
Detroit Service Station Westinghouse Elec. & Mfg. Co.
Detroit, Mich.

Re-surfacing Valve Face on Cylinder Without Dismantling

The accompanying illustration shows the detail of the steam valve of a 15x18-in. 225-r.p.m. engine that we had in service for twelve years before needing repair. At the end of that time the surfaces marked *A* had worn enough to allow steam to blow past and begin cutting.

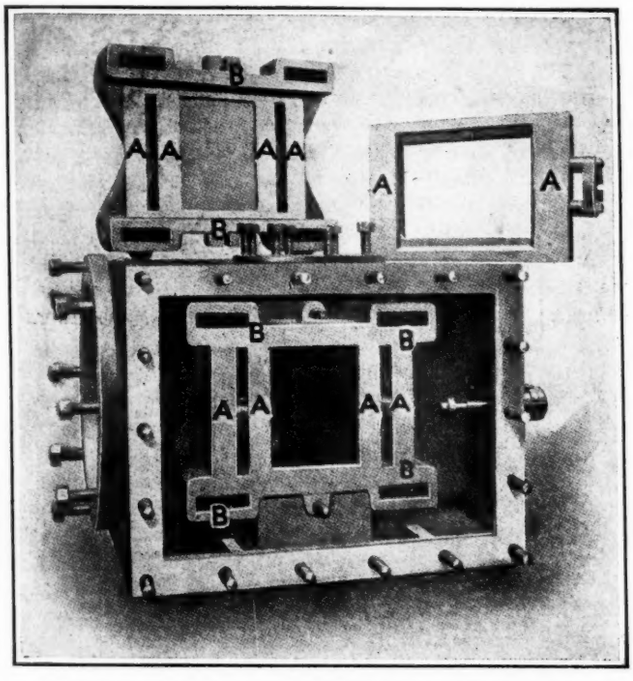
To disconnect the steam and exhaust pipes and unbolt the cylinder from the frame and send it to the machine shop for replaning, would entail considerable time and expense, so we called in a few machine-shop representatives and discussed plans for repairs on the job. The one we selected worked ideally. First a shop man came with block-files and straight-edge and started to work down the four high corners marked *B* on the cylinder face where the pressure plate rests.

While he was doing that, the shop cast and planed a surface plate large enough to cover the entire planed surfaces, but small enough to move about within the steam chest. When an approximately perfect job was done with the block-files, using the surface plate to spot with, we smeared the plate with grinding compound and worked the whole surface down to a perfect fit by turning the plate and working it by hand in all directions.

In the meantime we had taken the pressure plate and valve to the machine shop to be resurfaced on the planer. In doing so we first set the valve on the planer bed with its pressure-plate side up and took off the smallest possible amount to get a perfect surface. Next we put the pressure plate on the bed and cut a perfect surface on the bars marked *A*. We then clamped the valve in place into the pressure plate with a thin sheet of paper between the two new surfaces and took the combined faces of valve and pressure plate down to a perfect plane and surface at one operation.

One other small job made the repair complete. Before assembling we put grinding compound between the pressure plate and the cylinder face, leaving the valve out, and worked the pressure plate by hand till we were sure of a fine and perfect joint. The whole job was done in sixteen hours without rush, and gave us surfaces fully as perfect as when the engine was new.

To have sent the cylinder to the machine shop would have been a much longer and more costly job, and in my opinion no better results would have been obtained, while to have rigged up a suggested grinder on the valve-chest packing faces would have taken more than that time to get the equipment ready to start the job. I might also add that I was advised by several responsible engineer friends against the use of an emery



View of cylinder with valve and pressure plate

wheel for this work. They affirm that a grinder will embed small particles of abrasive into the closest-grained cast iron and make the new surfaces abrasive in action.

R. MANLY ORR.
Vancouver, B. C., Canada.

Not infrequently, waters which show no corrosive effect in their natural form have a decided corrosive effect when concentrated in the boiler.

Comments from Readers

Taking Care of Excess Water at Hydro-Electric Plant

Referring to J. C. Cummings' letter in the July 29 issue entitled "Taking Care of Excess Water at Hydro-Electric Plant," I would suggest that he put the question of blocking his units and letting full gate water run through them while at standstill up to the makers of the wheels, as they are the only ones in my opinion who have sufficient data to tell him whether this arrangement is feasible. It may be all right, but on the other hand he might get vibration or erosion on the turbine wheels.

Regarding temporary load in the tailrace, Mr. Cummings apparently feels that the spacing of the electrodes is an important feature. Long experience under many different conditions has proved that on water rheostats used on high voltage, spacing of electrodes does not have any appreciable effect. It seems to be all a question of surface contact.

You might assume that the current has the whole world to travel in once it is off the electrode. You can hang the electrodes in an equilateral triangle or in a straight line and space them anywhere from five feet up to fifty without any appreciable variation in the current or in the balance between phases. If you put two electrodes in multiple, they will carry more current if they are two or three feet apart than if they are hung side by side. The carrying capacity of the water varies greatly with the amount of salts, etc., in the solution, and the only way of telling what will happen under any given condition is to experiment.

I would recommend, if it is not feasible to block the wheels, that he place three electrodes in the tailrace and run temporary lines to them. A little experimenting will tell whether or not surface arcing is going to take place. We would not expect this under usual conditions unless there are a number of salt springs or discharges from some chemical plant feeding into the stream. Where conditions of this sort give heavy current from the electrode, the rapid formation of gases and steam drives the water away from the electrodes and an arc is drawn.

These conditions give rapid variations of the load and might cause voltage troubles from breaking of the arc. This, however, is more likely to occur with higher voltages.

I do not anticipate that Mr. Cummings will have any trouble of this sort. If this proves to be the case, it will simply be a question of getting enough area in the electrodes to carry the load. He will not have to make fine adjustments as he can vary his load by varying his voltage. He should, of course, take particular care to see that the rheostat is protected so that no one will be hurt. A rheostat of this sort is liable to kill some fish and even cook them, and small boys and others may be inclined to investigate to see what it is all about, with disastrous results.

N. L. REA.

Schenectady, N. Y.

Relations Between the Engineer and the Plant Management

Several articles have appeared lately dealing with the relations between the engineer and the plant management. The feeling seems to be general that the engineer does not get the attention he should, and that his ideas are not asked for often enough when matters are being discussed on which he is thoroughly posted.

Mr. Douglas in his article in the July 22 issue, entitled "The Industrial Executive—His Power Plant and His Engineer," apparently feels that the fault lies largely with the engineer himself, for not selling his ideas and opinions to his superiors. Carrying this a step farther, I should say the main stumbling block is this—big words.

There is hardly a branch of engineering that does not have something or other to do with "big words"—technical expressions, heavily worded statements, etc. These are as familiar to us as the saw and hammer are to the carpenter, because they are our tools, our stock in trade. But don't we get so steeped in this stuff that we forget that our bosses, the non-technical men, look upon these things as so much Greek?

Suppose a power plant engineer makes a report to his superior, recommending the purchase of a new machine or instrument which he is sure will soon pay for itself. Does he compose his report carefully, trying to keep away from technical discussions that his superior will not understand, and trying to make clear in simple language the points that will make his superior become enthusiastic over the idea?

If you think so, just get out the last three or four reports you have written, forget that you have any technical knowledge, and see whether they carry their message across. Or, better yet, take them home and let your wife read them.

Put yourself in your executive's place. He has gone away for a month and he has put you, the power plant engineer, in his place to direct the entire factory. The second morning the chief accountant comes in with a plan for adding to his books a complete system for taking care of obsolescence of all factory equipment. He talks to you as though you were a fellow accountant, familiar with his language. You ask him what he would do if the economical life of a machine were estimated at eight years, and at the end of the tenth year the machine was found to be still modern. He gives you a complicated explanation telling you how this will be adjusted on the books.

You do not understand, but you resolve to study it out at your leisure. Just as you start, a superintendent comes with a problem in labor handling. One thing after another, and you never get around to your study. Well, that is just what happens to some of the technical discussions you hand to your superior.

Try putting short paragraphs, short ideas, short sentences, and short words into your next report. Your executive will then be able to understand what you are driving at the first time he reads it, and you will find

that you will get action on your report. You will not insult your boss by using homely comparisons and expressions to bring out your points; instead, he will more probably feel elated that he is able to understand a report on a technical subject.

If you find, in talking over with him some of your work, that there is a phase of it that is not clear to him, do not take up his time explaining the whole thing to him. Go back to your office and build up carefully a written explanation. Hunt for some comparison that will bring your story within the range of his own experience.

W. J. RISLEY, JR.

Philadelphia, Pa.

Proper Application of Gaskets

I wish to take exception to a statement made in the June 3 issue in the article entitled, "Piping Materials, Valves and Gaskets for High Pressures and Temperatures," which read as follows: "With gaskets in general, their proper installation is most important. This is accomplished only when the bolts are drawn up tight and uniformly over the complete bolt circle."

The first sentence of this statement is correct and I agree that the proper installation is important, but it has been my experience during eleven years of work with gaskets that extreme tightness is not necessary, particularly with thick metallic gaskets of the flexible variety. In fact the greatest difficulty I have encountered has been to convince users that it is not necessary to tighten thick flexible metallic gaskets with the same extreme pressure that must be applied to thin non-flexible gaskets.

The prevalent idea seems to be that a gasket, in order to prevent leakage, must have as little thickness as possible and must be squeezed so thin that the distance between the faces of the flanges is practically nil. Very often when applying gaskets, we see the engineer or pipefitter slip a piece of pipe over the wrench, thereby increasing the leverage and making it possible to still further increase the pressure against the gasket. As a result the elastic limit of the metal of which the gasket is made is passed, the gasket is flattened out, and the original elasticity can do no good whatever. In my opinion it is poor practice to slip a pipe over any wrench or any gasket, because wrenches are generally made of a proper and safe length to fit the nuts for which they were intended, and nut sizes are usually standardized to fit certain bolt diameters. This is a logical safety measure that has been almost universally adopted so that the bolt will not be subjected to too great tension. An extra long handled wrench, unless used with extreme care, is liable to break the bolt or strip the threads.

One serious objection to the very thin gasket is that no matter how it is constructed it can have but little expanding or contracting capacity, consequently all expansion and contraction must be taken care of in some other manner—by means of pipe bends or expansion joints. A thicker gasket, having elastic properties, will naturally take care of considerable expansion and contraction. In many cases with which I am familiar, thick flexible gaskets take care of all the expansion and contraction in the line under ordinary temperature conditions of non-superheat practice.

Where temperatures are high or fluctuate considerably, copper, brass and other metallic gaskets having a coefficient of expansion different from that of the joint, should not be used. On account of the difference in the coefficient the gasket and the joint tend to expand and contract independently of each other. The tightly bolted joint, being much stronger than the thin gasket, will compel the gasket to expand and contract along with it. Breakage and leakage of a serious nature are therefore often the result. A gasket made up of steel that has the same coefficient of expansion as the joint, overcomes this latter trouble entirely, but if it is thin and non-flexible, it does not overcome or assist in overcoming the longitudinal expansion troubles.

Hence, when applying certain types of thick flexible metallic gaskets, be certain that a wrench of the correct length is used and then tighten only enough so that leakage is prevented. Any further tightening after leakage is stopped simply reduces the elasticity of the gasket and does not give it an opportunity to "breathe" as is should simultaneously with the expansion and contraction of the pipe line.

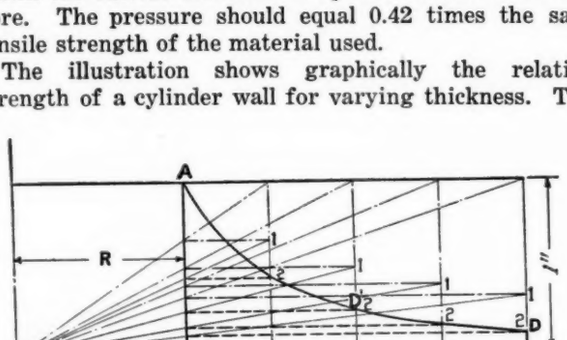
I therefore regard the matter of tightening as the most important of all and wish to impress it upon all users of gaskets. By being as careful in tightening the gasket as one is when tightening an ordinary steam-engine stuffing box or when taking up the wear in a bearing, the best results will be obtained, and if directions are carefully followed much labor and fatigue will be avoided.

HENRY BOHMER, Vice-Pres.,
Camden, N. J. Flexitallic Gasket Co.

Thickness of Cylinder Walls

Referring to the inquiry of M. C. in the June 10 issue, the following may be of interest, although it refers principally to cylinders for hydraulic presses. The most economical proportion for a hydraulic press is one in which the outside diameter is equal to 1.5615 times the bore. The pressure should equal 0.42 times the safe tensile strength of the material used.

The illustration shows graphically the relative strength of a cylinder wall for varying thickness. The



Shows relative strength of a cylinder wall for varying thicknesses

area of *A-B-C-D* times the tensile strength of the material equals the breaking stress. The diagram is made for 1 in. radius and for thickness up to 2 in. *R* equals radius of bore, *B* to *A* equals 1 in.

It might also be added that one can readily see that after the wall reaches a thickness equal to one-half the radius, the addition of more metal adds relatively little strength. In fact if the inside pressure per square inch exceeds the tensile strength (unit strength) of the material used the wall will crack regardless of thickness.

Hamilton, Ohio. EDWIN L. PLUMMER.

Speed Regulation of Underfeed Stokers

With reference to the article, "Speed Regulation of Underfeed Stokers," in the July 1 issue, my experience with large underfeed stokers has led to conclusions that disagree decidedly with those reported in the article in question.

Operating experience and a large number of tests on boilers from 14,000 to 19,000 sq.ft. of heating surface would lead me to rewrite Mr. Richardson's first paragraph as follows:

> It is of greatest importance to impress on power plant operators that to secure the highest boiler efficiency the rate of coal feed must be kept always proportional to the supply of air to the boiler.. The boiler furnace may be likened to a chemical mixing tank, in which it is necessary to proportion the amount of chemicals with the greatest care in order to secure uniformly good results. These ideas apply not only to powdered fuel and oil, but particularly to the combustion of coal on underfeed stokers.

In our particular plant the boiler meters have been adjusted to bring the air flow and steam flow pens together when the CO_2 reaches 14 per cent, corresponding to about 30 per cent excess air.

With the fuel bed in such condition as will give 12 per cent CO_2, a reduction in the air supply of 5 per cent shows an increase to 13 per cent CO_2 in 3 to 4 min., reaching 15 to 16 per cent CO_2 at the end of 30 min. The effect on the steam flow is immediate, though not so marked; while uptake temperatures follow a curve agreeing closely with the excess-air curve.

The absolute certainty of the changes has been established beyond possibility of a doubt with our stokers (underfeed) and coal (high-grade bituminous). I cannot believe that the data presented by Mr. Richardson tell the whole story or even represent experience.

The evils of disregarding a careful proportioning of air to coal supply are increased under induced-draft conditions. Increasing the rating from 210 to 265 per cent by starting a fan without increasing the coal feed proportionately will develop bad holes in the fire in fifteen minutes. It will, of course, take a much longer period to bring the fire back to its original condition.

Although, as Mr. Richardson observes, the amount of coal stored on the grate of an underfeed stoker is large, it is not relatively so when the rate at which it is burned is considered. However, it is true that a change in the rate of feeding coal does not affect the efficiency so quickly as a change in the air supply. A change of 20 to 40 per cent in the air supply, as shown by Mr. Richardson's curves, without corresponding change in the coal feed, would be considered radical by most engineers, I am sure. In our particular installation changes of 3 to 5 per cent are sufficient to counteract changes in fuel-bed conditions.

We have run for an entire shift without touching either coal or air feed on certain boilers (underfeed stokers with clinker grinders), at the end of which time the fire had changed so little as to be hardly noticeable, while the CO_2 recorder showed practically constant CO_2.

As a good example of hand operation approaching automatic attention, a test was recently run on a boiler equipped with an underfeed superstoker. The coal was fed at constant rate for four days (160 per cent rating). Air-supply dampers were all closed except the front windbox damper, which was used for regulation; the rest of the fuel bed received sufficient air due to damper leakage to maintain correct shape and thickness of fuel bed, together with occasional changes in the side-bar adjusters, which were not moved for hours at a time. The CO_2 obtained did not vary appreciably over this period of four days, and averaged 14 per cent.

It is not the purpose of this article to discuss automatic regulation, though the author considers it desirable inasmuch as it detects changes in steam pressure, draft over fire, and fuel-bed conditions, and corrects for them before they would be noticed by a fireman. In any case the regulator should be so arranged that the ratio of fuel to air supply can be changed at will, and also that operation may be under control of either the master regulator or the fireman as conditions demand.

H. H. BAUMGARTNER.

Newark, N. J.

Measuring the Feed Water in a Boiler Test

The article and criticism of W. Q. Perkins in the May 27 issue, entitled, "Measuring the Feed Water in a Boiler Test," recalls a method I once used of obtaining some data on a boiler that I had recently equipped with shaking grates, the boiler being used for heating and process work. As no water meter or scales for weighing the coal were available in the boiler room, I proceeded in the following manner:

The boiler-room equipment included a vented receiver tank approximately 30 in. in diameter by 8 ft. long equipped with a gage glass, so the first thing done was to measure the capacity of the tank, which was found to be approximately 300 gal., or 2,457.35 lb. A motor-driven triplex pump was used for boiler feeding and was equipped with a high-and-low-water, automatic float-controlled switch. By closing all returns to the tank and shutting off the makeup water, I could pump the tank empty and proceed to refill. The tank was emptied and refilled ten times.

The next important consideration was to get the coal measured, or weighed. After constructing a box of one-cubic foot dimensions and weighing out some coal on the nearest available scales, I found the average weight to be approximately 50 lb. per cu.ft., so I shoveled coal into a pile 5 ft. long by 4 ft. wide and 1 ft. deep, or 20 cu.ft., which, at 50 lb. per cu.ft., gave 1,000 lb. of fuel.

When one pile was used up, a fresh pile was made during the interval between firings. The temperature of the water as fed to the boiler was taken and recorded in the usual way. After the run, the data obtained were tabulated, and although not strictly accurate, they give some indication of the boiler operation and also show what can be done with a limited amount of equipment.

1.	Duration of test, hours	8
2.	Weight of coal as fired, lb.	3,000
3.	Weight of water fed to boiler, lb.	24,573
4.	Average steam pressure, lb. gage	82
5.	Average feed water temperature, deg. F.	150
6.	Factor of evaporation	1.10
7.	Efficiency of boiler and furnace, per cent	67
8.	Percentage of normal rating developed	68
9.	Actual evaporation per lb. of coal as fired, lb.	8.19
10.	Equivalent evaporation per lb. of coal from and at 212 deg. F	9
11.	Heating value of coal, B.t.u.	13,000
12.	Cost of coal per ton (delivered)	$10.00
13.	Size of boiler, sq.ft. of heating surface	1,400
14.	Grate area, sq.ft.	33

Tubes were blown with a steam soot blower located at the front end of boiler. The fire was shaken lightly and kept bright at intervals of two and one-half to three hours.

LEROY BLAKE.

Worcester, Mass.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Reinforced Concrete Foundations

For making a good job, should not the concrete foundation of an engine be reinforced? *N. T.*

Reinforcement of concrete is principally for the purpose of adding to its tensile strength, for without reinforcement the tensile strength may be very low. Generally, where the concrete is made of good material and properly laid, reinforcement is unnecessary except at places where recommended by the builders of the engine or where tensile stresses would be introduced from unequal settings, as in the extension of the main foundation footing under a wheel pit for supporting an outboard bearing.

Cooling and Utilizing Heat of Oily Drips

We have a number of low-pressure drips, including those from exhaust-steam piping, a closed exhaust-steam feed-water heater, exhaust head and returns from the exhaust-steam heating system which are not suitable for returning to the boilers, as they contain considerable oil. These drips are sources of considerable nuisance, and we must provide for better cooling of the hot water before it is discharged to the sewer. How can we dispose these oily drips to better advantage? *B. N.*

The returns can be cooled more promptly by discharging them through a closed type of feed-water heater connected between the boiler-feed pump and the regular exhaust-steam feed-water heater. In this manner much of the heat contained in the drips can be utilized, and their temperature should be reduced low enough for their discharge directly to the sewer, or at least after being passed through the present receiver. Connections with the regular heater should be provided with bypass and stop valves for cutting the drip heater in or out of use as required. The waste water space of a feed-water heater, used in this manner as a primary receiver of drips, should have a vapor relief pipe open to the atmosphere and also should be provided with suitable means for drainage and cleaning.

Gage Cocks in Water Columns

What is the purpose of supplying the water column of a boiler with gage cocks as well as a glass water gage? *R. H. T.*

Water gage cocks are provided to serve as a check on the glass gage in case the indications of the glass are not dependable because it is dirty, the connections are clogged or there is leakage of the stuffing boxes; or for use in case of breakage and during cleaning or replacement of the glass. The upper gage cock is also convenient for use as a pet cock for discharging air from the boiler when first filled with water and for admission of air when draining the boiler and for checking the accuracy and sesitiveess of the pressure gage at atmospheric pressure.

Locating Striking Points to Show Piston-Travel Clearance

How can the amount of piston-travel clearance of an engine be bound from marks so made that the amount of clearance can be quickly determined at any time? *W. S. G.*

Disconnect the connecting rod from the crosshead. Make a mark on the crosshead to register with marks made on one of the guides when the crosshead, piston and piston rod are moved as far as possible with the piston pressed hard against the head in one end, and then the other end, of the cylinder. The points thus made on the guide and crosshead may be regarded as registers of the striking points at either end of the cylinder when the engine is on a corresponding dead center, and there is the same adjustment of length of the piston rod. Then the amount of piston-travel clearance obtained at either end of the cylinder, for a given adjustment of the connecting-rod brasses, is readily seen at any time by placing the engine on a center and observing the distance between the mark on the crosshead and the striking point on the guide.

Shorter Cutoff Required When Operating Condensing

The load on our engine, operated non-condensing, requires cutoff at about one-half stroke, with the initial pressure of steam 110 lb. gage and back pressure of 3 lb. above the atmosphere. What would be the point of cutoff for the same load with the same initial pressure, when operating condensing with 26 in. vacuum? R. W. L.

The theoretical mean forward pressure per pound initial absolute pressure, with admission of full initial pressure from the beginning of the stroke to the point of cutoff, perfect cutoff, hyperbolic expansion to the end of the stroke with release at the end of the stroke, would be given by the formula:

$$P_m = (1 + \text{hyp. log } R)\ (f + c) - c$$

where P_m is the pressure per pound initial, R the actual ratio of expansion including clearance, f the fraction of stroke at cutoff, and c the percentage of clearance.

Tables giving values of P_m obtained per pound of initial pressure, with cutoff at different fractions of stroke and different percentages of clearance, are given on page 115, Low's "Steam Engine Indicator," and

quoted in *Power*, page 897, June 6, 1922. From the tables it may be found that for cutoff at one-half stroke and 5 per cent clearance, the mean forward pressure per pound of initial absolute would be 0.8556 lb. per sq.in. Then with an initial pressure of 110 lb. gage, or 110 + 15 = 125 lb. per sq.in. absolute, the theoretical mean forward pressure would be 0.8556 × 125 = 106.95 lb. per sq.in., and with back pressure of 3 lb. gage, or 3 + 15 = 18 lb. per sq.in. absolute, the theoretical mean effective pressure would be 106.95 — 18 = 88.95 lb. From rounding off of an actual diagram at cutoff and release, and reduction of forward pressure by compression, the m.e.p. of an actual diagram would be only 85 to 95 per cent of the theoretical, depending on the conditions. For present purposes this percentage, called the diagram factor, may be assumed to be the same whether the engine is operated non-condensing or condensing. With this assumption the point of cutoff when operating condensing may be based on the theoretical requirement for development of 88.95 lb. m.e.p. with the same initial pressure of 125 lb. absolute when the back pressure is 26 in. vacuum, or (30 — 26) 0.491 = about 2 lb. per sq.in. absolute, thus requiring 88.95 + 2 = 90.95 lb. per sq.in. mean forward pressure or 90.95 ÷ 125 = 0.7276 lb. per pound average forward pressure.

The actual ratio of expansion necessary to obtain this value could be found by substituting trial values in the formula. However, a simpler method is to obtain the fraction of cutoff from inspection of the tables referred to, from which it may be seen that with 5 per cent clearance the value quoted nearest to 0.7276, namely 0.7259, is obtained with cutoff at thirty-four hundredths of the stroke. This then, under the conditions stated, would be the approximate point of cutoff required when operating condensing, in order to obtain the same mean effective pressure and development of the same indicated power by the engine as when operating non-condensing with cutoff at one-half stroke.

Loss from Twice Handling Return Water

For returning the high-pressure condensate from laundry machinery and low-pressure returns from heating coils, we are at present gathering all condensate and returns in a receiver vented to the atmosphere and discharging the receiver by a lifting trap to another receiver placed at a level above the boiler-feed pump. There is no feed-water heater, and the feed-water temperature is about 190 deg. F. How could the method of returning the water to the boiler be improved?

L. J. R.

In place of handling the high-pressure condensate twice—that is, by trap and feed pump—there would be a saving of steam by separately returning the high-pressure condensate directly to the boiler, using the present trap or one suitable for the purpose, placed above the level of the boiler. The low-pressure returns should be discharged directly into a vented receiver placed below the level of the low-pressure apparatus, and the feed pump should be placed 18 to 24 in. lower than the receiver, and any makeup water required can be supplied to the receiver. If these arrangements are not feasible, all returns and makeup water might be discharged to the first receiver, as at present, and fed to the boiler by the feed pump, placed below the level of the receiver.

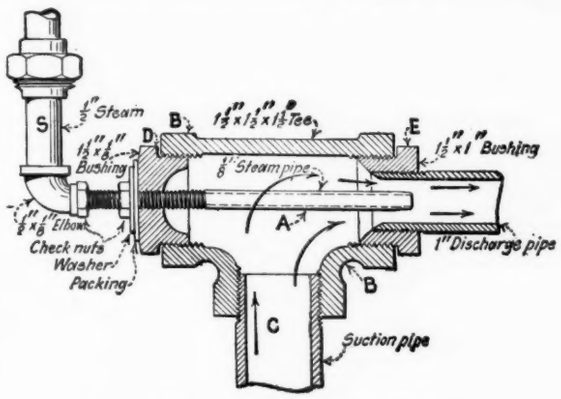
By handling the high-pressure returns separately, their temperature as delivered to the boiler may be higher than the present temperature of the combined returns, but there would be no gain of total heat returned to the boiler. The advantage would arise from not being required to handle the feed water by trap or feed pump more than once.

Jet Pump Made from Pipe Fittings

How can a steam jet pump be made from ordinary fittings for raising water from an engine flywheel pit?

W. L. C.

The general construction of a jet pump made from ordinary pipe and fittings is shown in the illustration. A steam jet pipe *A* connected to a steam supply pipe *S* is extended through the run of a tee *BB* having a side outlet *C* for the suction connection and one end outlet



Assemblage of fittings for jet pump

for the discharge connection, as shown in section. The jet pipe *A*, with check nut, washer and packing, is screwed through a bushing *D* in one end of the run of the tee, and the discharge end of the jet pipe, tapered on the outside, projects into the main discharge connection that is set in a bushing *E* in the discharge end of the tee. When steam is first discharged through the jet pipe, its flow produces a partial vacuum in the tee and suction pipe, and water rising into the tee is swept along with the steam and condensate delivered to the main discharge connection. The exact fittings or proportions of sizes shown need not be followed so long as the general arrangement of passages and orifices is obtained, but for good operation of the jet pump it is essential to use a tee large enough to permit of easy passages of the water from the suction to the discharge connections, and for the same reason the bushing *E* and entrance to the main discharge pipe should be countersunk to form a gradual contraction of the water passages to the internal diameter of the discharge pipe.

The jet pipe *A* should be provided with a screw thread of length equal to several diameters of the pipe on each side of the bushing *D*, for advancing or withdrawing the tapered end of the jet pipe to such a position with respect to the discharge end of the tee as may be found most efficient for the particular conditions of construction and operation of the jet pump.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications, and for the inquiries to receive attention.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

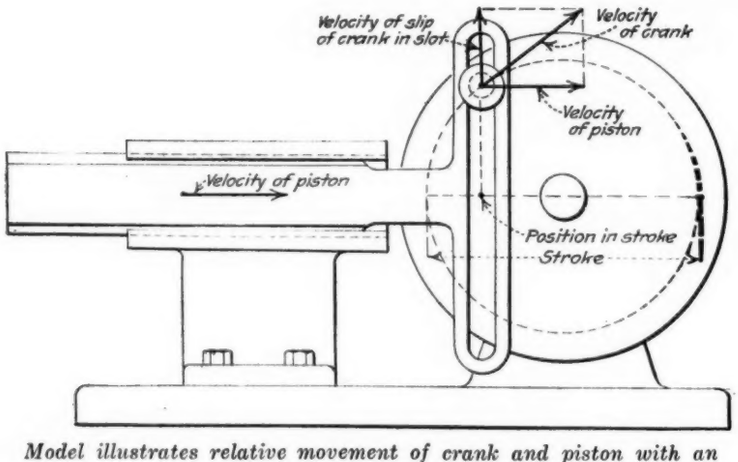
How Fast Does the Piston Move?

IN AN ordinary steam engine, where the shaft turns at a practically constant speed, the piston travels fastest at a point near the middle of its stroke. As it approaches the end of the stroke, it moves more slowly, until at the end of the stroke it apparently comes to a dead stop before starting back. There used to be many arguments among engineers as to whether the piston was ever co..pletely at rest. The question, being of a philosophical rather than a practical nature, must be approached from that point of view.

Two cases may be considered. One is a theoretical or "paper" engine in which all parts are perfectly rigid, and all guides, bearings, etc., are absolutely free from lost motion. For such an engine the definite statement can be made that the piston comes to an absolute stop at the end of the stroke. Where the motion of a body is absolutely along a straight line it must come to a dead stop before it can start moving back along the same line, since at some instant it is moving neither forward or backward. The idea that it would not stop may have arisen from the second fact, which is that the duration of this stop is theoretically zero. This is something that the mind cannot picture and yet is obviously true, namely, that the piston comes to a dead stop and yet that it is absolutely still for zero time, so that in ten minutes of time, for instance, the piston is in motion for a full ten minutes.

With an actual engine it is conceivable that the piston might never come to an absolute stop provided a slight degree of play permitted an infinitesimal up-and-down motion at the end of the stroke. The whole question is purely academic, but at the same time interesting to the engineer with a philosophical leaning.

It is of equal interest, and also of some practical value in connection with the study of engine balance, to know the speed of the piston and its rate of acceleration at various points in the stroke. The angularity of the connecting rod—that is, the varying angle it makes with the piston rod—complicates the problem somewhat, so it is best to start first with an engine having an infinitely long connecting rod. The piston will then move back and forth with "simple harmonic motion" like that of a pendulum. While an infinitely long connecting rod cannot be constructed, the same effect may be produced by the model shown in the figure. In this model the slot gives the exact effect of an infinitely long connecting rod.



Model illustrates relative movement of crank and piston with an infinitely long connecting rod

The piston velocity may easily be found graphically in the manner indicated. The velocity of the crankpin is tangent to the circle it moves in. This is laid off to scale. Completing the rectangle gives the horizontal and vertical components of this velocity. The horizontal component is the velocity of the piston, crosshead and all other horizontally moving parts. The vertical component is the velocity with which the pin is sliding up the slot.

The movement of the piston is exactly represented by that of the center point of the slot. At the moment pictured in the illustration, the piston has moved 20 per cent of the stroke. By imagining the model at various points of the stroke, with the velocity rectangle drawn with a diagonal of the same length in each case, it becomes evident that at the center of the stroke the piston velocity is equal to that of the crank. At all other points the piston velocity is less than that of the crank, although it is not much less for any point in the middle third of the stroke. At the two ends of the stroke the rectangle flattens out into a single vertical line, showing that the piston velocity is zero at these two points. When the crank is one or two degrees from dead center, the piston velocity is so small as to be hard to measure on the rectangle. It can easily be obtained at such points by multiplying the crank velocity by the sine of the angle between the crank and the center line of the piston.

Figured in this way, the relation between the piston velocity and that of the crank is as shown in the accompanying table.

RELATION OF PISTON VELOCITY TO CRANK VELOCITY

Angle Between Crank and Piston Center Line, Deg.	Piston Velocity, per Cent of Crank Velocity
0	0
1	1.7
2	3.5
3	5.2
4	7.0
5	8.7
6	10.5
7	12.2
8	13.9
9	15.6
10	17.4
20	34.2
30	50.0
40	64.3
50	76.6
60	86.6
70	94.0
80	98.5
90	100.0

This same table shows the surprising fact that the acceleration of the piston is greatest when it is moving most slowly and least when it is moving fastest. Since the rotative speed is constant, angles may represent times and the percentages of crank velocity may represent actual velocities. Taking one degree as the unit of time and starting with the crank on dead center, the piston velocity picks up 1.7 in the first unit of time and practically the same amount in the second, third, etc. intervals of time. The acceleration (or rate of pick up) does not reduce appreciably till the crank is 20 deg. up. The average increase in velocity per deg. from 20 to 30 deg. is 1.58. From 30 deg. to 40 deg. it is 1.43; from 40 deg. to 50 deg., 1.23; from 50 deg. to 60 deg., 1.00; from 60 deg. to 70 deg., 0.74 and from 70 deg. to 80 deg., 0.45. The average from 80 deg. to 90 deg. is only 0.15. At 90 deg. it drops to zero.

The effect of the connecting rod is to increase somewhat the acceleration at one end of the stroke and decrease it at the other. The connecting rod also shifts the point of maximum velocity and zero acceleration a little from the center of the stroke, although it still remains at the 90-deg. position of the crank.

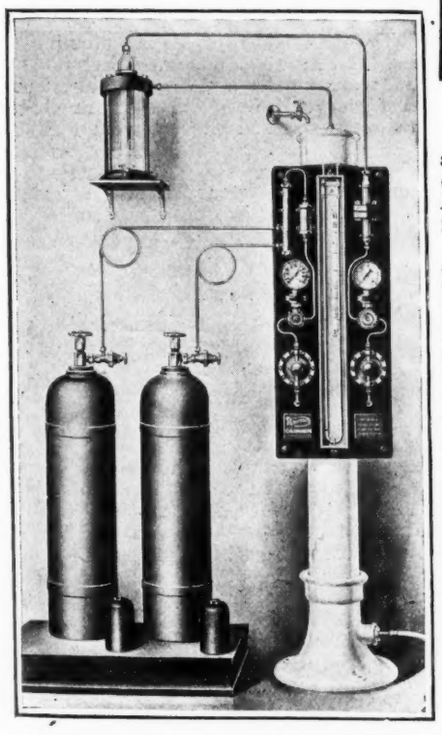
New and Improved Equipment

Chlorine Treatment for Circulating Water

A process for the treatment of steam-engine and turbine cooling water with chlorine, so as to prevent the fouling of condenser tubes, has been developed by William Paterson, London, England. The amount of chlorine used, is extraordinarily small, not exceeding one-third of a part per million. This, however, it is claimed, is a sufficient quantity to prevent the growth of vegetable and animal organisms, which form an effective non-conducting deposit on the inside of the condenser tubes.

Known as the "Chloronome" method, the new system embodies this principle of chlorine treatment for volumes of water up to 75,000,000 lb. per twenty-four hours. The system is operated from a control board to which 70-lb. cylinders of liquid chlorine are connected. The control board includes a filter for the chlorine and two pressure-reducing valves, bringing the pressure down accurately to 10 lb. Gages and meters show the exact amount of chlorine passing. The gas then passes through a seal of concentrated sulphuric acid, which prevents any moisture passing back to the apparatus from the water, and subsequently goes into a vertical absorber, consisting essentially of a glazed earthenware tower filled with pumicestone, down which a trickle of water is allowed to pass. The chlorine is thus completely absorbed and the water which runs out continuously at the bottom is a dilute solution of chlorine, which passes direct to the main supply of the cooling water at the circulating-pump suction. The quantity of chlorine used seldom exceeds that previously stated, even when the cooling water is contaminated by sewage.

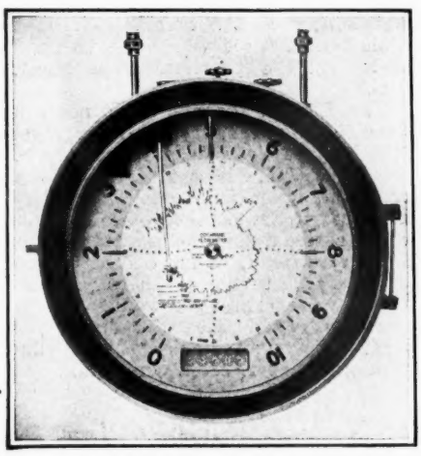
The process would appear to have many possibilities other than those associated with boiler-plant practice, especially for the purification of municipal water supplies.



Apparatus used in connection with the chlorine-water treatment

Cochrane Corporation Adds Integrating Device to Its Flow Meter

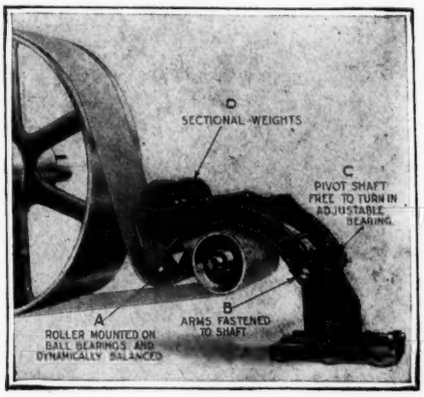
A recent improvement to the flow meter developed by the H.S.B.W.-Cochrane Corp., Philadelphia, Pa., about two years ago and described in detail in the Oct. 10, 1922, issue of *Power* is the addition of an integrating device.



General view of flow meter

This integrating mechanism it is claimed imposes no load or resistance to the deflection of the U-tube which forms an essential part of the actuating member, so that sensitivity and accuracy are undiminished. The integrator is driven solely by the clock, the deflecting member of the meter merely controlling the position of a stop or motion-limiting pin.

A feature of this meter is the use of a uniform scale on the indicator dial and the recorder chart, instead of the usual distorted scale with spacings proportionate to the square of the flow. It is claimed that when properly adjusted the meter will give results within one per cent of absolute accuracy in a run during which the flow varies between 20 and 100 per cent of full load rating. Provision is made in the instrument for readily calibrating or checking it for accuracy. A general view of the instrument is shown in the illustration.



Typical installation of drive

The Bird Machine Company Pulmax Drive

Where there is a large difference in the diameters of the driver and the driven pulley in a belt drive and where the pulleys must necessarily be placed close together, some means must be provided to increase the belt wrap on the smaller pulley and maintain a certain tension on the belt, if the best results are to be obtained. To meet this requirement the Bird Machine Co., East Walpole, Mass., has brought out the drive (Pulmax) shown in the illustration.

The device consists of an idler pulley *A* resolving on ball bearings supported by the arms *B*, which in turn are attached to the shaft *C* supported by a bearing pedestal. The idler pulley *A* is held against the slack side of the belt by the sectional counterweights *D*, which are readily adjustable to give any desired tension.

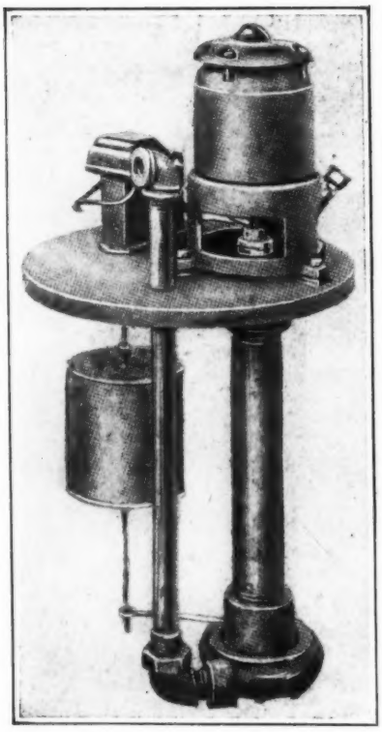
This drive is made in several types to meet practically any installation requirement.

Goulds Centrifugal Cellar Drainer

The Goulds Manufacturing Co., Seneca Falls, N. Y., has recently added to its line of pumps a motor-driven centrifugal sump pump especially adapted for draining cellars, pits, pipe trenches, etc.

The pit cover which supports the motor and from which the pump is suspended is 20 in. in diameter and fits the bell of a standard 18-in. sewer pipe. The pump is suspended by a 2½-in. pipe and made suitable for a pit depth of 24 in. It is constructed with cast-iron volute casing, bronze impeller and tobin-bronze shaft. The motor, which is ¾-hp. vertical type, is connected to the pump through a flexible coupling, the pump shaft being supported by a ball thrust bearing directly below the coupling.

Current to the motor is controlled by



Sump pump assembly

a totally inclosed, double-pole, float-actuated switch mounted on the pit cover. The capacity of the pump at 1,750 r.p.m. ranges from 10 gal. per min. at 24-ft. discharge head to 35 gal. at 13-ft. head. A view of the pump assembly is shown in the illustration.

London Steam-Flow Meter

The well-known Napier formula is an accurate method of computing the flow of steam through nozzles where the terminal pressure is less than 0.58 of the initial pressure. This formula is as follows:

$$W = \frac{PA}{70}$$

where

W = Weight of steam discharged in pounds per second;
P = Absolute pressure in pounds per square inch;
A = Nozzle area at the throat in square inches.

While accepted as theoretically correct, in practice 72 gives a closer approximation than the original constant of 70. Changing this formula, therefore, from pounds per second to pounds per hour and using 72 instead of 70, we get the following formula for the flow of steam in pounds per hour:

$$W = \frac{PA \times 3600}{72} = 50\,PA.$$

It is therefore apparent that a pressure gage placed at the inlet of the nozzles is in itself substantially a steam-flow meter if the pressure registered is multiplied by the area of the jet and by the constant suggested. Upon this principle, W. J. A. London, of Hartford, Conn., inventor of the London turbine, has devised a steam-flow meter consisting substantially of a steam-pressure gage with an additional dial attached thereto which will read directly the flow of steam passing through the nozzles.

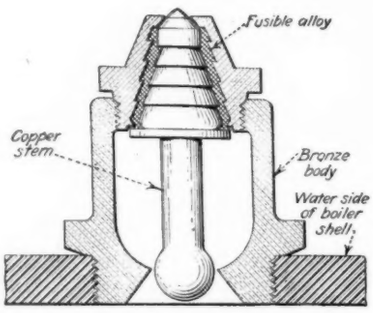
In order to make this gage or meter practicable, it is necessary to have some means whereby the recording dial can be adjusted to suit different nozzle areas in the turbine. To obtain this result, a compensating mechanism has been connected to the pointer of the gage whereby the pressure is not recorded in equal increments but on a logarithmic scale. In front of the pressure recording dial is a rotating dial, also divided off in a logarithmic scale, which can be adjusted to suit the nozzle area of the turbine or other apparatus employed.

It is apparent that if a dial were fitted to an ordinary pressure gage and so calibrated for the correct nozzle area of a particular turbine, the pointer would, in turn, automatically record the flow of steam through the nozzles. However, it would necessitate a separate dial for recording the flow for each machine. With this device, having the pressure gage arranged with a logarithmic scale, an adjustable dial can be fitted so that this dial can be adjusted covering a wide variation of nozzle area in the turbine. Separate dials can be fitted where the variation is beyond the practical scope of one dial.

The London instrument is not confined to direct-reading meters or gages, but the principle can be applied to recording gages either of the dial type or of the cylindrical type. It does not attempt to take the place of the regular steam-flow meters now on the market; instead, it has a field for use with small turbines where a more expensive instrument would not be warranted and also for use with turbine-driven auxiliaries where a close approximation is often desirable.

Vulcan Fusible Plug

The illustration shows a fusible plug that has been used extensively in Great Britain and in the marine service. The plug is of rather unusual design and a radical departure from the types of plugs used in this country.



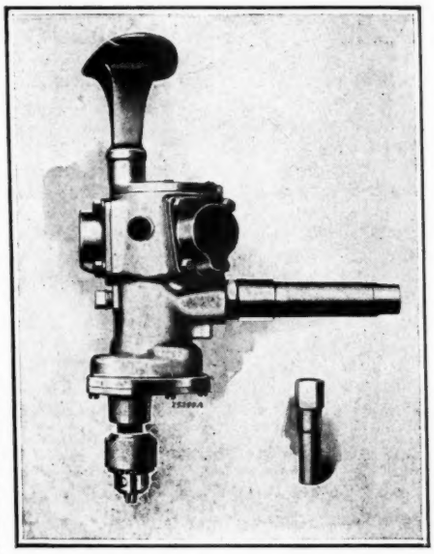
Fusible alloy is totally enclosed on water and five sides

The plug consists of a bronze body and bronze cap, into which a copper plug is inserted with fusible alloy between the copper plug and the cap, thus the alloy is totally enclosed on the water and fire sides. The heat of the fire is transmitted to the alloy by means of the copper stem; the cavity in the bronze body through which the stem passes being protected from accumulation of dust. Visible warning is also given if the plug should fuse with no steam in the boiler.

This plug is put out by the Vulcan Boiler & General Insurance Co., Ltd., Manchester, Eng.

Ingersoll-Rand Light-Weight Pneumatic Drill

The Ingersoll-Rand Co., New York City, has recently added to its line of pneumatically operated tools a light-weight non-reversible drill suitable for light drilling up to $\frac{9}{16}$ in. diameter holes and reaming up to $\frac{5}{16}$ in. in diameter.



Light-Weight Pneumatic Drill

The drill is built with an aluminum case having steel bushings cast in all the bearing holes and throttle hole. The cast-iron cylinders, three in number, are renewable and interchangeable. The drill may be fitted with either breast plate, feed screws or grip handle as desired and so made adaptable for a wide variety of work. The details of this drill are as follows:

Recommended working speed at 90 lb. air pressure, r.p.m.	700
Weight (including breast plate and chuck), lb	14
Length of feed (with feed screw), in.	2½
Size of twist drill will drive, diameter, in.	⅜
Size reamer will drive, diameter, in.	⅝
Length overall (with breast plate and chuck), in.	15
Distance from side to center of spindle, in.	1½
Size hose recommended, in.	¾

Where economizers are installed it is desirable that the feed should be so regulated that it is continuously passing through the economizer into the boiler. Otherwise, if the boiler is fed intermittently, at one time a large amount of water will be passed through the economizer and at another the water will be standing still in the economizer. Under the latter circumstances the water may become heated above the temperature corresponding to the safety-valve load and steam may be formed in the economizer, leading to overheating of the tubes in the upper parts or "water hammer" action and serious damage.

Alcohol as a Source of Power*

By CHAS. H. BEDFORD

THE enormous development of the use of the internal-combustion engine and the consequent demand for petrol as a fuel for it is, of course, one of the oustanding features of present-day civilization. The world is faced with a serious problem as regards future supplies of fuels for internal-combustion engines. Nobody who has first-hand knowledge of the position regarding world supplies of oil, can escape the conclusion that we are within sight of a definite and progressive shortage of supply, which must be made up from some, preferably, non-mineral source.

When all alternatives have been examined, one is forced to the conclusion that alcohol is the hope of the future in this respect. At the present time alcohol fuel is used in the form of mixtures with benzol, petrol, ether, etc., in various parts of the world, but in certain countries it is the only available indigenous fuel for internal-combustion engines. When we remember that the world's output of oil, the British Empire supplies under 3 per cent of the whole, we are forced to realize in how precarious a position we stand with regard to motor fuel, which is produced and largely owned by foreigners.

Advantages of Alcohol

It is scarcely necessary to touch on the now well-recognized advantages of alcohol as a fuel and its complete suitability for use in internal-combustion engines. It need only be said that suitable alcohol mixtures can be employed in existing types of internal-combustion engines, with at least equally good results as petrol, and alcohol, chiefly as a supplement to petrol supplies, is becoming an increasingly important factor in the fuel situation. The use of alcohol alone requires increased compression and carburetor adjustment, with modified throttling for starting up from the cold. Engines designed to run on alcohol alone will obviously be built only when alcohol supplies are assured in sufficient quantity and at a safe competitive price.

Throughout the world today alcohol is being produced from starchy or sugary materials, as it has been for many years past. There is no more suitable source of manufacture, for example, than molasses, as being a waste product from sugar manufacture, and with a high alcohol yield, but the quantity of molasses produced throughout the world can supply only a fraction of the amount of alcohol needed for fuel purposes.

There are other sources, such as rapidly expansible annual crops like sugar cane, maize, sweet potato and cassava, and other grains and starchy roots, but even these cannot be regarded as supplying an adequate and permanent solution of the difficulty as regards large-scale, cheap supply.

The hope of the future, with respect to very large-scale alcohol production, rests in obtaining it from true waste materials, such as cereal straws, sawdust, waste wood, certain grasses and such cellulosic waste products. Tropical production is essential for the large quantities of raw materials required, as also manufacture of the alcohol alongside these supplies.

The existing aims have been to convert the vegetable material into sugar (with subsequent fermentation to alcohol and distillation) by means either of very weak or of highly concentrated acids, such as hydrochloric, sulphuric, etc. The weak-acid process has been successfully used commercially to produce somewhere between 20 to 30 gallons of 95 per cent alcohol per ton of raw material, and in certain instances it has been operated so as to produce a high proportion of paper pulp as a secondary product, thus cutting down the cost of production of the alcohol.

The other method is to employ concentrated acids and to obtain high yields of alcohol; for example, 50 to 60 gal. of 95 per cent alcohol per ton of raw material, of course with no paper production in this case. The cost of acid recovery in the latter process has been one difficulty hitherto, but certain workers now claim to have overcome this objection. It may, however, be said at the present moment that there is no known and accepted process that can certainly be stated to produce alcohol from waste vegetable materials on a commercial scale and at a competitive price with petrol.

Microbes Produce Alcohol

Other efforts have been made to produce alcohol by the action of various micro-organisms on cellulose, and some interesting and encouraging results have been obtained. This process cannot be claimed to be on a practical commercial basis. The same must be said of the efforts to obtain alcohol by synthetic methods, as, for example, from ethylene and acetylene. Consequently, sugary and starchy bases are the stand-bys now and for some time to come, in the absence of practical alternatives.

Selection of a suitable center for a distillery in relation to nearness to supplies of raw material, and of adequate and cheap "in and out" transport facilities is of vital importance. The availability of suitable land and labor to work it, the arrangements that can be made to keep the distillery plant working throughout the greater part of the year by supplementary supplies of more than one raw material to meet seasonal and other conditions, sufficient and cheap fuel and water supplies for the distillery are of primary importance to success. The question of labor is becoming, in certain tropical countries, a problem calling for long-sighted views, for if we must raise our raw materials in the tropics, we must depend on native labor, as Europeans cannot, for physical and economic reasons, be employed.

To maintain constant and regular supplies that will not be liable to be cut off by strikes or price combinations is becoming an increasingly less easy problem, and Europeans ordinarily cannot compete with any agricultural enterprise carried on by numerous native small holders. In the Gold Coast cocoa production has shown this very clearly.

Apart from tropical producing lands there are, in countries like India, enormous areas under waste raw materials, such as rice straw. The labor supplies for the rice straw are already available, and those for bamboo or elephant grasses can be obtained with more or less ease, according to topographical and other conditions. But, though rapidly approaching, the time has not yet arrived for such exploitation—that is, until we obtain the suitable manufacturing process required to convert waste vegetable material cheaply and readily into alcohol. Meanwhile, we must, as far as possible, take stock of the requirements and make our plans accordingly, so that, when these conditions are present, we can go ahead promptly. In India at least this has, to some extent, been done, as I can testify from personal experience.

Raw Material

Without going into details, it can be stated that in Australia, New Zealand, South Africa, Rhodesia, Kenya, Nyasaland, Gold Coast, Federated Malay States, British Guiana and the West Indies active production or experimental investigation of the possibilities of producing power alcohol is being carried on, from raw materials offering the most favorable economic conditions in the particular area. Molasses, maize, sweet potatoes, flax, pulp, cassava and nipah palm, are chiefly the bases employed.

Until a few years ago alcohol as a fuel was almost entirely confined to use in small stationary engines, in Germany in particular, but during the last ten years considerable work has been done toward the production of a fuel, of which the basis is alcohol, suitable for use in motor-car engines.

There are innumerable patented mixtures with varying amounts of alcohol in their compositions, but perhaps the three fuels that are best known are alcogas, discol and natalite. These fuels have been manufactured for some time in fair amounts and have been used successfully.

Natalite is a complete substitute for petrol. In this it differs from most other alcohol fuels. It is selfcontained; that is to say, it is essentially a mixture of alcohol and ether, the ether being easily and cheaply manufactured from alcohol. Small amounts of other substances are added to conform to the excise regulations, which require all power alcohol to be denatured or rendered unfit to drink, and for other special purposes.

Natalite can be mixed with petrol and can be used, therefore, either as a complete substitute or as a diluent for petrol. When mixed with low-grade petrol, it has been found that a fuel quite equal to a No. 1 grade gasoline is obtained, and that an engine using such a fuel gives no sign of any knocking, and that more power is developed.

Natalite requires, for best results, a

*Extract of paper read before the First World's Power Conference, London, June 30.

little larger jet than petrol, but a natalite petrol mixture requires no alteration whatever to the engine. Starting up with either product is a matter of ease on even the coldest day. It has been shown by Ricardo that it is at least one-third easier to start an engine using natalite than with petrol.

The consumption of natalite is rather greater than that of petrol under the same conditions, but the power developed is at least four to five per cent greater (Ricardo) and there is no trace of knocking. It can be used in engines having a very high compression ratio; as high as seven to one has been successfully used without detonation taking place.

For the time being it is not expected nor is it desired that alcohol should replace petrol entirely as a fuel for motor cars, etc., and it would be unwise to think that a desirable object. It must, clearly, for some time yet, be developed in conjunction with petrol, and in this way conserve the world's petroleum resources. Bearing this in mind, and by reason of the fact that alcohol can be produced cheaply in almost any part of the world and can provide an excellent fuel at a price that should not materially increase, it must necessarily follow that it must prove to be an extremely valuable factor in promoting the development of the British Empire.

Utilizing Byproduct Heat and Moisture in Flour Mill*

By E. K. Campbell

A problem that has been of great interest to millers is that of byproduct heat and moisture. In the grinding process a large amount of heat is generated, and along with it a definite amount of moisture is thrown off from the grinders as a result of treating the grain with water. In the paper a description is given of an installation in a flour mill by means of which these byproducts are recovered and utilized to help heat and humidify the flour mill.

The building is eight stories high and contains about 1,500,000 cu.ft. of space, of which 850,000 cu.ft. is to be heated. An outline of the requirements follows:

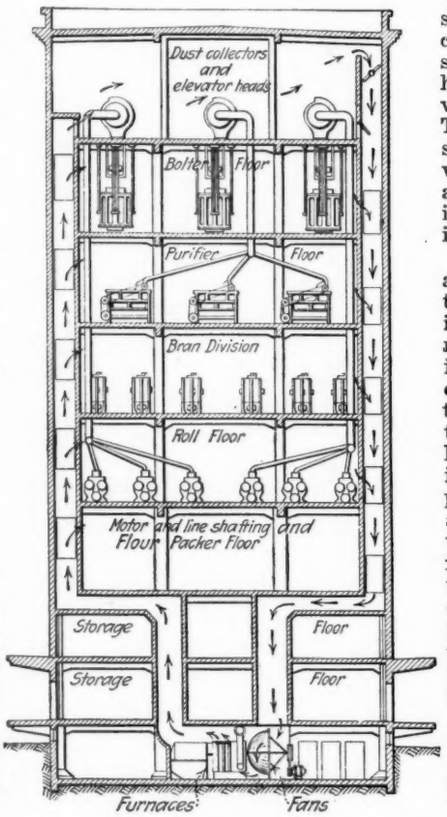
1. To heat the third floor of the mill to 60 deg. F. and all floors above this level to 70 deg., whether the machinery is in operation or not; no heat to be provided for the first and second floors.

2. To humidify the mill while in operation and provide approximately 65 per cent humidity summer and winter.

3. To ventilate the mill in the summer while operating, and remove the surplus heat from the grinding process.

4. To use the byproduct heat and moisture to help heat the mill when in operation during the heating season.

It was apparent that a direct steam system would meet only the first two problems unless combined with a separate ventilating system which would run up the cost and still leave the problem of saving the byproduct heat. A furnace blast system in which the individual unit can be quickly stopped or started, was installed. On the basis of 70 deg. within the building with an outside temperature of 10 deg. below zero, the heat loss of the mill approximated 3,000,000 B. t. u. per hour. To supply this loss four furnaces were installed. These furnaces have been developed particularly for industrial work, and the firebox is built of ⅛-in. locomotive firebox steel of high tensile strength and protected inside by a fire pot of fireclay tile just as in a smaller steel furnace. The flame and gases of combustion pass into a second chamber, or radiating drum, containing 21 vertical tubes, each 8 in. in diameter and 5 ft. long, giving a total heating surface for the furnace of 452 sq.ft.



Sectional elevation through mill showing duct system laid out on recirculating plan

With four of these units a safety margin over the estimated requirement has been provided. The four furnaces are set in one brick enclosure so that one or more can be fired as occasion requires. The air is moved over these furnaces by two 8-ft. fans or low-pressure volume blowers of the modified cone type with blades in the shape of a half-globe. Each fan delivers about 100,000 cu.ft. of air per minute and gives a change of air once every 8 minutes.

The illustration represents a cross-section of the mill, showing the duct system as arranged for recirculation. The fans at the bottom of the return shaft draw the cold air off each floor through openings located close to the floor, pass the air over the furnaces and drive it through the supply duct on the opposite side of the building into the various rooms. All openings are dampered so that the temperature can be controlled as desired.

When the mill is not in operation, it is necessary to maintain the proper percentage of humidity to protect the stock in the mill and also to keep the air in proper condition for the employees. Another humidifying problem is presented during the summer months when the heated air from the dust collectors is discharged from the mill, carrying the moisture with it. To supply this humidity, spray heads have been installed in the rising column of air, using compressed air for atomization.

In the particular mill under discussion there are 30 cloth tube dust collectors which discharge air into the seventh and eighth floors, so that the heat discharged into the seventh floor will rise promptly into the eighth. These dust collectors were supposed to solve the dust problem, so that no air washers or other means of cleaning the air would be required, but experience in this regard has been somewhat indefinite as yet.

This type of dust collector discharges all the air of the conveyor system and therefore the heat which is generated in the grinding process inside of the mill, except the heat that is carried out in the warm finished products. This condition creates two problems—one, the expelling of this heat in the summer time, and the other, the saving of the heat during the winter. The ventilating problem in the summer is accomplished by drawing in a volume of cool air to the fan and creating a pressure within the mill just as in any plenum fan system. The air is forced out of the building through large ventilator openings in the roof above the eighth floor. The ventilators are opened in the summer and closed in the winter. This method drives out a large part of the heat, and dampers can be controlled at the various openings so that the pressure can be directed against the top floor or any other floor should it show any tendency to accumulate surplus heat. With the fans in operation all night, the building will become thoroughly cool and can be kept comfortable by the moving of the air even on the hottest days.

It was difficult to estimate the amount of heat recoverable, but the general rule accepted by the millers that 40 per cent of the horsepower installed in the mill is used in the grinding process and is turned into heat, was taken as approximately correct, and this was later substantiated in practice. Of the 1,210 hp. in motors, 1,075 hp. is used in the operation of the mill. Forty per cent of this is 430 hp., which is equivalent to 1,094,000 B.t.u. per hour, or slightly more than one-third of the estimated heat requirement of the building at 10 deg. below zero.

Without any fire in the furnaces the byproduct heat maintained a temperature of 70 deg. when it was 40 deg. outside, thus actually supplying three-eights of the total requirements, or about 1,250,000 B.t.u. per hour. When the machinery and the byproduct heat are doubled, it is hoped to double the fuel saving, although it may be necessary to speed up the fans to maintain bearable conditions on the top floor.

*Abstract of paper presented before semi-annual meeting of the American Society of Heating and Ventilating Engineers, at Kansas City, Mo.

Great Britain Six Years After the Peace

Some First-Hand Observations of the Economic and Social Status of the British Nation and People

By E. J. Mehren
Vice-President, McGraw-Hill Co.

THE war is past history in America, but current history in Great Britain.

So, indeed, it seems after spending a week in Britain's capital, conversing with her men of affairs and listening to addresses by her business leaders and statesmen. True, there are war scars in United States, scars that will never be erased. We are mindful of the men who died in the great struggle; we have great numbers of disabled veterans. On the financial side we still have, and will have for many years, a war-swollen budget and correspondingly increased income taxes. But, by and large, the war shadow has thinned out. In the last two years we have had "good times." Our war-time income tax rates have been twice reduced. Certainly the way is not blocked by serious obstacles. The difficulties we foresee are merely the fluctuations which, except for the "panic years," one might say are normal to business.

War Only a Yesterday

Not so with Britain. The war is only a yesterday with her, and the consequences are still sharp upon her. I do not mean that she is discouraged; that word has no place in the British vocabulary, nor has the state of mind it indicates any place in British consciousness. But the burdens that weigh her, the obstacles still to be overcome, are fully appreciated and are a stock subject of discussion with all her thinking men.

To enumerate some of the troubling factors:

There is still large unemployment—though the amount is lessening.

There is marked depression in the "engineering trades," as they are called here—shipbuilding, machine tool building, and the metal fabrication industries generally. In construction there are few large projects in hand, though there are a few that, after long delay, now seems likely to be taken in hand.

A new housing bill, that will again dip heavily into the national and into local government treasuries—and increase, accordingly, national and local tax burdens—is before Parliament.

The income tax rate on even small incomes is 4 shillings 6 pence per pound sterling, or 22½ per cent. The super-taxes are very heavy.

The Continental problem is acute and the consequent uncertainty, the upset exchanges, the diminished purchasing power, curtail British export markets.

Finally, the never-ending exchange of views with their Continental war Allies on German reparations, keeps before the British people constantly the fact that peace, though declared five years ago, is not yet here. There is cessation of military activity; there is not that accord which is peace in actuality.

That the consciousness of the international element in these difficulties is ever present with the thinking Britisher was strikingly demonstrated at the great advertising convention held here, at the British Empire Exhibition, last week. There were delegates from every country, though the United States sent the largest representation, 1,700 (including the ladies). To this great convention, man after man emphasized the distressed position of Europe and expressed the hope that out of the international discussions now under way in London, and participated in by the United States, there may come that peaceful adjustment for which Europe has been longing since that wonderful Nov. 11, 1918.

In private conversation one gets an even more serious picture of England's difficulties, for there the talk turns to social conditions. Briefly, the burden of these conversations can be reduced to just this: that the altruistic promises of war times and the coddling of politicians have taken from the mass of British workers a sense of responsibility for their own welfare and led them to expect the government to take care of them. Thrice, indeed, was the statement made to me, and in separate conversations, that there was a growing opinion, fostered by socialist agitators and politicians, that if the people would have the babies the government would do all else.

The worst of the difficulty is that no one with whom I have spoken about this attitude of the people seems to have any hope for early improvement. The politician—not the statesman—is the ruler of the day, and, as with us he does not hesitate to sell the public treasury in order to advance his personal interests.

Englishmen Not Discouraged

Withal, though, it should be repeated, that the Englishman is not discouraged. He has lived through a lot. He hopes that he will live through this trying period, and that a better day will come.

His way is not our way. We would think that his more or less complacent attitude might be fatal. He believes that the situation will turn out all right; we would fear that it would turn out all wrong unless vigorously handled. (One recalls our Unemployment Conference of some years ago.) We, I hope, would turn, so long as possible, to private measures of relief. The British have turned to the Government. The difficulties, of course, were very great; the amount of unemployment, for example, quite large. Possibly with similar conditions we would have been forced to a similar solution, but I am inclined to believe that the British tap the national treasury with less hesitation than we. The actual war, let us recall in possible explanation, lasted twice as long for them as for us.

But though our methods might differ from those of the British we cannot withhold our admiration of their sterling qualities. Similar conditions would put us in a panicky condition. They go on hanging out their sign "business as usual," confident that eventually all will be well.

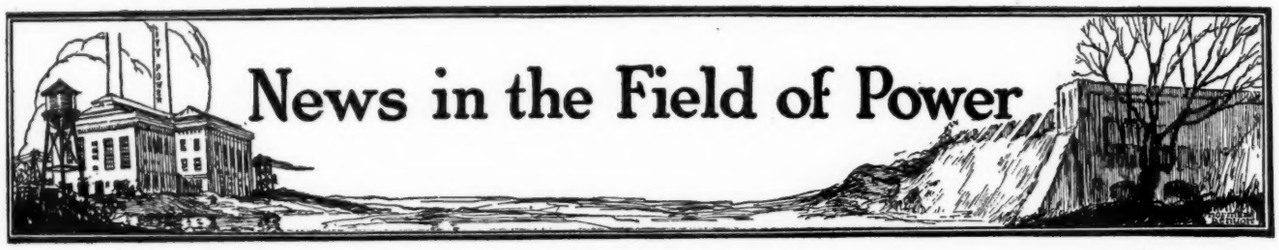
Looking back on their long and brilliant history, we, too, can feel confident that somehow the Briton will come out on top. Trial and difficulty develop stamina and character. They are developing them right now in business circles. In the wage earning classes the tendency is in the opposite direction. Eventually, under the example of conscientious leaders, even that tide should change.

Force Made Visible by Recent Research

Latest methods of testing the strength of engineering materials were described at a meeting of the Engineering Section of the British Association for the advancement of Science on Aug. 12. That the strength of a chain is that of its weakest link, is obvious, but it is not generally appreciated that every bridge automobile, or other structure or machine is a chain of which the different members or parts form the links.

Previous efforts of engineers to ensure that there shall be no weak links in these chains have been hampered by their imperfect knowledge of materials and the forces which act on them. Until recently it was only possible to estimate these forces mathematically or by the construction of models of the intended structure. While such methods are still used, Professor E. G. Coker of London, England, has perfected a method whereby forces can be made visible and measured, thus adding considerably to our knowledge of stress distribution and enabling steel and other material to be employed with greater efficiency and economy. For this purpose "polarized" light is passed through a transparent model of the part that is ultimately to be made in metal. When a measured force is applied to this model, the light passing through it is transformed into beautiful patterns of different colors. The shape and color of these patterns stress the intensity and direction of the forces acting in the specimen. Such investigations indicate where material can be removed with safety, in what ways the intended machine or structure can be improved, and also throw light on the causes of previous failures. In this way bridge members, ship plates, automobile gears, and other important parts have been, and are being, studied.

At the meeting today, Professor Coker described researches he has made by means of this method on the form and behavior of test pieces. This research has resulted in the recommendation by Professors Coker and Dalby of a new form of test piece in which certain inaccuracies, due to the specimens now commonly employed, may be avoided. This, and other recommendations of a similar nature, were discussed during the presentation of the report of a committee of the British Association which is assigned the task of investigating the question of the "More Complex Stress Distributions in Engineering Materials."



Geology of St. Lawrence Basin Must Be Known in Detail Before Further Investigation

Col. Kelly, Federal Power Commission, Believes Need for St. Lawrence Power is Imperative

BEFORE much further progress can be made in the investigation of the St. Lawrence project, extensive boring must be done, not only of dam sites, but at points where navigation structures are proposed, in the opinion of Col. William Kelly, chief engineer of the Federal Power Commission and member of the St. Lawrence Joint Engineering Board. After having made the trip along the river with the Hoover party, Col. Kelly returned to make a more exhaustive and detailed study of the situation than was possible during the first trip. He is more convinced than ever that the geology of the whole St. Lawrence basin is of a character which will require drilling before any conclusions as to the location of structures can be reached.

The Canadian sector of the improvement has been bored fairly well, Col. Kelly says, except in the channel of the stream. The Canadians, he point out, have had at their disposal an appropriation of $50,000 a year for five years for this investigation. The amount has been increased to $100,000 this year. There is urgent need that corresponding field work be done on the American side but no money is available for the purpose, although Col. Kelly anticipates that the money will be made available at the next session of Congress.

In Col. Kelly's opinion every effort should be concentrated on the steps necessary to bring in at least a part of the power at the earliest possible time. Since no less than ten years will be required before any power is made available, he anticipates that the power requirements of that portion of the United States which the project will serve will have reached a point before that time where the need for it will have become acute. In view of the probability that a much longer period may have to elapse before any of the St. Lawrence power is made available, because of the delays inherent in the securing of legislation and in the preparation and ratification of treaties, Col. Kelly suggests that no time should be lost in the necessary preliminary studies.

Because the need for St. Lawrence power is imperative unless there be a large-scale shifting of industry from the Atlantic seaboard and western New York, Col. Kelly anticipates that the financing of the project will not offer insurmountable difficulties, although rather intricate steps must be taken so as to prevent any increase in the tax burden which this generation of the Canadian people will have to pay. Canadian opposition to the project is losing ground rapidly, Col. Kelly observes.

Bids on Diesels for Panama Canal

The various locks of the Panama Canal are operated electrically by means of power generated at a hydro-electric plant. The damage that might be done to a vessel in a lock in case of failure of the hydro-electric system led to the decision of the canal engineers to call for bids on the installation of Diesel engine stations for standby service.

The specifications called for three 3,750-hp. Diesels direct connected to 2,500 kw. 25-cycle generators. No Diesel of this capacity has been built in this country but, as the bids revealed, several firms have done enough development work to justify their seeking the contract. An interesting feature is the number of engine builders who offered double-acting machines.

Choose Between Power and Navigation, Says Engineer

Four-fifths of the potential power resources of the St. Lawrence River are within Canada and within transmission distance of its largest industrial centers and mining areas, according to R. S. Lea, Montreal engineer, who addressed the British Association for the Advancement of Science, which was held recently in Toronto.

Projects for the advancement of the St. Lawrence waterway must choose between the primary purpose of power development on a scale necessitating the utilization of the whole flow of the river with provision for present and future navigation requirements, and the object of obtaining deep draft navigation sufficient for ocean-going vessels with incidental opportunities for power development—in brief, a choice between navigation and power development must be made.

The second plan is part of a more extensive undertaking to enable ocean shipping to reach the head of the Great Lakes, said Mr. Lea. From either point of view, the projects are of exceptional magnitude and importance, the minimum ultimate depth proposed for the locks and navigation channels being 30 ft. and the total power when fully developed amounts to from 4,000,000 to 5,000,000 hp., with individual plants having capacities of from 600,000 to 1,500,000 horsepower.

That an electric power shortage is in prospect, but that the future of the Ontario hydro-electric system is full of promise, was contained in a paper written by and read for F. A. Gaby, leading engineer for the system. He described the transmission network and the financial structure of the hydro system and dealt with the Queenston-Chippawa development and the chief sources of new power, according to press reports.

BIDS ON OIL ENGINES AND GENERATORS TO THE PANAMA CANAL—JULY 28, 1924

Engine Builder	B.H.P.	R.P.M.	Type Engine	No. Cyl.	Bore & Stroke	Price 3 Engs.	Engs. & Gen.	Per Cent High
Cramp	3,750	115.4	4 cyc. double act.	4	33 in. x 59 in.	$1,111,000	$1,188,000	69.0
Burmeister & Wain	3,750	115.4	4 cyc. double act.	4		@ 528,000	.....	.....
Falk Corp.	3,750	214	4 cyc. single act.	24	17½ in. x 22 in.	786,000	852,540	21.2
New London	3,750	.....	2 cyc. double act.	..	.....	.....	860,928	22.3
Sun	3,750	115.4	2 cyc. opp. piston	6	22.85 in. x 68 in.	1,349,000	1,457,900	110.7
Bethlehem	4,300	115.4	2 cyc. single act.	8	26 in. x 48 in.	.....	X) 871,129	.....
Bethlehem	3,750	115.4	2 cyc. single act.	7	26 in. x 48 in.	.....	X) 781,680	11.1
McIntosh & Seymour	4,400	100	4 cyc. double act.	6	30 in. x 60 in.	897,446	988,302	.....
McIntosh & Seymour	3,750	100	4 cyc. double act.	5	30 in. x 60 in.	792,455	883,311	.....
McIntosh & Seymour	3,750	115.4	4 cyc. double act.	4	30 in. x 60 in.	700,685	774,799	10.1
McIntosh & Seymour	3,750	115.4	4 cyc. double act.	6	30 in. x 48 in.	747,566	858,820	
Worthington	3,750	125	2 cyc. double act.	4	28 in. x 42 in.	678,000		9.35
Nordberg	3,750	115.4	2 cyc. double act.	6	29 in. x 48 in.	620,000	703,565	Base
Busch-Sulzer	3,750	125	2 cycl. single act.	6	30 in. x 42 in.	715,000	794,605	13

@ Exclusive of duty. X) Does not include factory load tests.

Madras State Considering Power Projects

The government of the Madras Presidency, according to *Commerce Reports*, proposes to take advantage of the Trade Facilities Act to finance an irrigation and hydro-electric power program. There are on the west coast of the Madras Presidency many water-power sites that can be readily developed, which sources of power are close by such important centers as Calicut, Coimbatore, Madura, and Koilpatti.

Increase in American Petroleum Production

The total supply of crude petroleum for the United States for 1923 was 814,422,000 bbl., an increase of 129,583,000 bbl. over the previous year, according to figures given out recently by the Department of the Interior. Domestic production for 1923 was 732,407,000 bbl., and imports 82,015,000 barrels.

Indicated crude petroleum deliveries to domestic consumers were placed at 714,316,000 bbl. and exports at 17,385,000 barrels.

Producers' stock of crude petroleum at the close of 1923 were 9,850,000 bbl., or an increase of 1,422,000 over the preceding year.

The number of oil producing wells in the United States on Dec. 31 was approximately 290,100, with an average capacity a well a day of 6.6 barrels.

Utica, N. Y., Considering a New Smoke Ordinance

The Common Council of Utica, N. Y., at the instigation of the Women's Civic Club, recently considered the matter of the smoke nuisance. The club for some time has had experts trying to solve the problem, among whom was Harry E. Collins. A new ordinance was finally drafted that was thought would meet the exigencies of the situation, on which a public hearing will be held Sept. 3.

The ordinance is:

"It is hereby ordained, determined and declared that Ordinance No. 167 presented September 1, 1903, and September 18, 1903, relating to smoke nuisance be and the same hereby is repealed and rescinded.

"1. It is hereby ordained, determined and declared to be a nuisance to burn any fuel in the city of Utica in such a manner as to discharge dense dark smoke therefrom over or upon any part of said city.

"2. No person, firm or corporation shall burn or cause to be burned any fuel in such a manner as to discharge dense dark smoke therefrom over or upon any part of said city, and upon conviction thereof shall be fined not less than twenty-five ($25.00) nor more than fifty ($50.00) in any one day.

"3. For the purpose of determining by comparison the degree of darkness of smoke emitted within the city of Utica, a color scale of measurement shall be and the same is hereby adopted.

"4. One thickness of grey glass of sufficient capacity to cut off sixty (60) per cent of the light from a flame having the lighting power of sixteen (16) candles shall be taken as the basis of said scale, and four (4) thicknesses of such glass shall be known and designated as No. 1 scale.

"5. That smoke of greater degree of darkness than No. 1 scale shall be considered and held to be dense smoke, and the emission or the escape thereof within the City of Utica, from any smoke stack, chimney or other part of any boat, locomotive, stationary engine, steam roller, steam derrick, steam pile driver, steam shovel, tar kettle or other similar machine or contrivance, or of any building or premises, except for a period of three (3) minutes in any twenty (20) while in constant operation, or six (6) consecutive minutes in any one hour during which the fire box is being cleaned out, or a new fire being built therein, except between the hours of 6 a.m., and 7:30 a.m., shall be deemed and same is hereby declared a nuisance. The instrument used in measuring the density of smoke is known as the standard smoke tester or "Umbrascope."

"6. There shall be an officer in the city of Utica, known and designated as smoke inspector, who shall be qualified by training and experience in proper combustion of fuel and practice of smoke abatement. This officer shall be appointed by the mayor, and shall become effective January 1, 1925. He shall be a citizen of the United States and a resident of the city of Utica.

"7. If it should be determined by the smoke inspector structural changes are necessary in installations now in use to fully comply with the provisions of this ordinance, the offending corporation or individual shall be given five years time to make such changes.

7. It shall be the duty of the smoke inspector to personally inspect all chimneys, smoke stacks, and other appliances for the escape of smoke.

"9. The smoke inspector may advise as to the properties of fuel best adapted to the requirements of any particular installation but shall have no power to prescribe to any consumer or recommend any fuel handled by any particular dealer or dealers. Also, the smoke inspector shall have no authority to recommend the device of any particular man or agent or any particular make of smoke consumer or other device."

Coal Division of Commerce Department Has New Head

C. P. White, formerly in charge of distribution for the United States Fuel Administrator, will head the coal division of the Department of Commerce. This position has been vacant since the resignation of F. R. Wadleigh. The place was offered to Mr. White at that time but just then he was not in a position to accept it. Secretary Hoover felt the place might well be left vacant until a properly qualified man could be found. He also was influenced by the fact that the coal division was in the capable hands of F. M. Shore, who has been acting chief since Mr. Wadleigh's resignation. Mr. White served as as assistant to Mr. Wadleigh while the latter was Federal Fuel Distributor. At that time Mr. White was in charge of the situation at the head of the Lakes.

Date of N. E. L. A. Convention Announced

The date for the next meeting of the National Electric Light Association has been fixed for the week beginning June 15, 1925. While the convention will be held on the Pacific Coast, some doubt exists as to the city in which it will be held. In all probability, however, it will be held either in Portland, Ore., or San Francisco. San Francisco has solicited the meeting, and telegrams have been received from the Mayor, the San Francisco Chamber of Commerce and numerous other organizations urging the association to come to the city of the Golden Gate. On the other hand the claims of Portland, the home of the president of the N.E.L.A., cannot be ignored. If, after a thorough canvass of the hotels, the local Chamber of Commerce can guarantee enough and suitable hotel accommodations, the convention may go to Portland, which possesses an excellent auditorium large enough for meetings.

United States Exports of Leather Belting

The United States, according to *Commerce Reports*, in the fiscal year ended June 30, 1924, exported 1,064,960 lb. of leather belting, valued at $1,870,186. According to quantities received, the principal markets were, in the order named, South America, Cuba, China, British India, Mexico, United Kingdom, Canada, Japan, and Philippine Islands.

South America shows an increase of 6.6 per cent over the quantities purchased from the United States during the previous fiscal year, the United Kingdom, an increase of 32.4 per cent, and the Philippine Islands, an increase of 72.1 per cent. China required 143,903 lb. in 1924, as compared with 209,552 lb. in the fiscal year 1923. The Canadian demand for American manufactured leather belting was less in 1924.

The following table shows by principal countries of destination, the quantity, and the value of leather belting exported from the United States during the fiscal years ended June 30, 1923 and 1924.

United States exports of leather belting

Country of Destination	Twelve Months Ended June 30—1923 Pounds	1923 Value	1924 Pounds	1924 Value
United Kingdom	62,010	$105,908	82,124	$136,564
Canada	121,248	141,255	80,308	96,742
Mexico	108,552	165,547	102,608	161,913
Cuba	157,301	270,008	146,447	252,593
So. America	154,168	213,331	164,385	253,541
Br. India	112,956	173,405	123,005	191,611
China	209,552	323,710	143,903	209,026
Japan	36,121	57,408	30,565	43,475
Philippine Islands	17,492	33,977	30,111	53,364
Other countries	161,903	239,728	161,504	271,357
Total	1,141,303	1,724,277	1,064,960	1,670,186

Tippecanoe River Power Project

Development of a new water-power project at Oakdale, on the Tippecanoe River, about 10 miles below the site where the Norway water-power project, the first of the kind in Indiana, recently was completed, is to be started within sixty days by the Indiana Hydro-Electric Co. The officers of the Hydro-Electric Co. are officers of the Interstate Public Service Co., in which a controlling interest has been obtained by the Middle West Utilities Co. Another site on the Tippecanoe is owned at Springboro.

The new plant, consisting of a dam and power station, will cost, when entirely completed, about $2,000,000. It will be larger than the Norway plant and will be operated by the Interstate Public Service Co. Surveys for the new project have been completed and work preliminary to actual construction now is proceeding. The engineering work is being done by Roger M. Freeman, of New York. The plant will have a 42-ft. operating head as compared with a 30-ft. operating head for the Norway dam, and the power plant will have an approximate capacity of 14,000 kw., while the Norway plant has 8,500 kw.

Law for Commercialization of Resources in Rumania

The Rumanian Chamber of Deputies, on April 6, passed the bill providing for "commercialization and control of the economic enterprises of the Rumanian State." The purpose of the law is to prescribe the methods and formulate the regulations under which the Rumanian government proposes to conduct its state enterprises and to exploit the natural resources of the country, in co-operation with private capital, both native and foreign, it is stated.

Under the terms of the law those industries forming a state monopoly, as well as those dealing with the national defense and those performing important public services on which the development of the national economy depends, will be managed under the immediate direction of the state administration and will be operated exclusively on state capital. Under this category are the Rumanian state railroads, the posts, telegraphs and telephones, and the Rumanian state monopolies, as well as all ammunition-producing establishments and the repair shops necessary for the proper functioning of these enterprises.

One feature of the legislation is that which creates a monopoly for the distribution of petroleum products in the interior of the country. This particular provision has been made the subject of protests, by the association of petroleum industrialists, to the Minister of Industry and Commerce. The latter, in his reply, points out that "it is the state's duty to organize the distribution of oil products in the country, and on the following general lines: First, that the needs of the internal market for oil must have priority; and, second, that internal prices for oil products should not be greater than world market prices."

Enterprises that will come under the scope of the law, aside from those mentioned above, and industries in which private capital may participate, are those industries of a purely commercial character that are exploiting state properties but not as an exclusive monopoly. In this classification are included the exploitation of mining and metallurgical lands, state bathing establishments, Rumanian river transportation, Rumanian maritime service, state forests, fisheries, slaughter-houses, refrigerating plants, and power plants; also the operation of any state rights, such as the distribution of petroleum products, etc., according to *Commerce Reports.*

Rensselaer Institute Program for Centennial Celebration

The Rensselaer Polytechnic Institute, Troy, N. Y., the oldest college of science and engineering in any English-speaking country, is to celebrate its centennial Oct. 3-4.

There will be present official delegates from educational institutions, scientific organizations and engineering societies throughout the world, as well as from each alumni association and from each class since 1857. The program of exercises is as follows:

PROGRAM

Friday morning, Academic procession; convocation; addresses by Herbert Hoover, Secretary of Commerce; Alfred E. Smith, Governor of New York; Harry E. Clinton, mayor of Troy; Frank Pierrepont Graves, president of University of New York State; Sir Charles Langbridge Morgan, president of the Institute of Civil Engineers of Great Britain; Henri Abraham, president of the Society of Electrical Engineers of France; Luigi Luiggi, president of the Society of Civil Engineers of Italy; Roberto Gayol, honorary president of the Society of Engineers of Mexico; Arthur Surveyer, president of the Engineering Institute of Canada.

Friday afternoon — Unveiling of tablets, (1), On the site of the old Main Building, destroyed by fire in 1904; addresses by Hon. Seymour van Santvoord, of Troy, and Mrs. James Carroll Frazer, of Washington, a lineal descendant of Stephen Van Rensselaer, founder of the Institute. (2) In the Carnegie Building in memory of S. Wells Williams '32, first professor of Chinese and Oriental literature in Yale University; address by Dr. S. K. Alfred Sze, Chinese minister to the United States.

Friday evening — Inspection of Laboratories; dinner in the state armory; addresses by Livingston Farrand, president of Cornell University, Citizens of Delaware and another distinguished speaker; pageant on the campus illustrating scenes in the history of science and engineering during the last hundred years.

Saturday morning—Convocation; addresses by President Angell of Yale University, President Birge of the University of Wisconsin, President Stratton of the Massachusetts Institute of Technology, President Grunsky of the American Society of Civil Engineers, President Low of the American Society of Mechanical Engineers, President Kelly of the American Institute of Mining and Metallurgical Engineers, President Osgood of the American Institute of Electrical Engineers, President Michelson of the National Academy of Sciences.

Saturday afternoon — Reception by President Ricketts and Mrs. Ricketts; alumni meeting.

Saturday evening—Pageant; alumni smoker.

Coal Dumpings Increase During Past Week

Indications of a decided revival in business were being registered throughout the past week in the central offices in Washington of the far flung systems of fact and figure finding, which are maintained by the Government and by more than 300 trade associations.

Coal already has responded to the improvement in business, and is expected to reflect promptly the prospects of a fall and winter likely to be marked by great industrial activity. There has been a sharp increase in tidewater dumpings. This reflects the increase in industrial activity in New England and at other points which secure their coal supplies from the coastwise trade. Dumpings have been at a rate higher than any level reached since March and close to the maximum for the year. All rail shipments to New England have increased. There has been a gradual increase in the amount of coal dumped at lower lake ports.

Since no one expects 1924's production of coal to fall under 450,000,000 tons, production at an accelerated rate cannot be delayed much longer, it is pointed out. Since the railroads last year handled in excess of 10,000,000 tons of coal for a period of 16 weeks, there is no serious talk of a car shortage.

Water-Power Projects

Mississippi River Project. — A preliminary permit has been authorized by the Federal Power Commission for the Pike Rapids Power Co., of Duluth, covering a power project on the Mississippi River, ten miles down stream from its Blanchard Rapids development and at the head of the pool of the Watav development. The Blanchard Rapids project is under construction. There is a 22-ft. drop between the Blanchard Rapids dam and the Watav pool, which will permit of the installation of equipment sufficient to generate 10,000 additional horsepower.

Hydro-Electric Plant for Gasconade River—Ten million dollars is named as the ultimate cost of the water-power project on the Gasconade River in Missouri for which the Central Missouri Power & Water Co. holds a preliminary permit from the Federal Power Commission. A lake 50 miles long and from half a mile to a mile in width will be

formed by the erection of a 95-ft. dam. The continuous horse-power available is estimated at about 30,000, and plans have been made for the installation of six or seven 5,000-kw. generators.

Another Project for Green River, Utah—An application for a preliminary permit covering a 60,000-hp. development at the Split Mountain site on Green River in Uintah County, Utah, has been filed with the Federal Power Commission by A. E. Humphreys, of Denver, and by J. H. and Mary E. Ratliff, of Vernal, Utah. The proposed project conflicts with plans of the Utah Power & Light Co., which holds a preliminary permit for the Flaming Gorge site, several miles above Split Mountain, on the Green River. Mr. Humphreys and his associates propose to develop a head of 160 ft. and to install five units capable of generating 60,000 hp., which is to be used in the manufacture of fertilizer at the near-by phosphate properties of the applicants. In addition, however, it is proposed to divert sufficient water to irrigate 3,000 acres on the east side of Green River and 8,000 acres on the west side of the stream.

Obituary

Baron Carl H. Nordfelt, a well-known engineer in the turbine contract service department of the General Electric Co., died at Lynn, Mass., Aug. 5. He was a native of Sweden and was about fifty-four years of age. He entered the employ of the company in 1912.

Business Notes

The McClave-Brooks Co., Scranton, Pa., reports that it has secured the services of Harlan W. Bird to represent it in the State of Indiana who will have his headquarters in Indianapolis.

The De Laval Steam Turbine Co., Trenton, N. J., is announcing the appointment of G. C. Kahl, 404 Dwight Bldg., Kansas City, Mo., as its sales representative in Arkansas, Nebraska, Kansas, Oklahoma and part of Iowa.

The Oil Boiler Works, Oil City, Pa., advises the trade that there has been a change in its Atlanta office, which is now to be known as the Oil City Boiler Works, 315 Glenn Bldg., and which will be in charge of John C. Chandler, district sales manager.

Merrill-Ferguson Engineering Co. of West Virginia is the new firm name for the company formerly known as the Ernest M. Merrill Engineering Co. The new firm will open offices in Charleston at 506 Kanawha Banking and Trust Bldg. The offices at Beckley, Mullens and Madison will continue as at present.

The Chicago Pneumatic Tool Co., 6 East 44th St., New York City, is making some personnel changes: Ross Watson, formerly district manager of the Cleveland branch office, will be transferred to the Minneapolis branch as district manager, to succeed D. M. Wesbrook, now general manager of the Canadian Pneumatic Tool Co.; L. J. Westenhaver was recently transferred from the Pittsburgh office to Cleveland as district manager of that branch; E. C. Stroup, compressor engineer in the Boston territory, has been moved to the Pittsburgh district.

Coming Conventions

American Ceramic Society. Ross C. Purdy, Lord Hall, Ohio State University, Columbus Ohio. Convention at Los Angeles, Calif., Oct. 6-7.

American Chemical Society. Dr. Charles L. Parsons, 1709 G St., N. W., Washington, D. C. Sixty eighth meeting at Cornell University, Ithaca, N. Y. Sept. 8-13.

American Electric Railway Association. James W. Welsh, 8 West 40th St., New York City. Meeting at Atlantic City, Oct. 6-10.

American Electrochemical Society. Dr. Colvin G. Fink, Columbia University, New York City. General meeting at Detroit, Mich., Oct. 2-4.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Fall convention at Pasadena, Calif., Oct. 13-17.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Autumn meeting at Birmingham, Ala., Oct. 13-15.

American Society of Civil Engineers. 29 West 39th St., New York City. Fall meeting at Detroit, Oct. 23-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Dec. 1-4.

American Society of Refrigerating Engineers. W. H. Ross, 35 Warren St., New York City. Annual meeting at New York City, Dec. 1-3.

Association of Iron & Steel Electrical Engineers, John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Annual meeting and exposition at Duquesne Garden, Pittsburgh, Pa., Sept. 15-20.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Eighteenth annual meeting at Hotel Chelsea, Atlantic City, N. J., Nov. 12-14.

Exposition of Inventions. American Institute, 47 West 34th St., New York City. Exposition to be held in the Engineering Societies Building, 29 West 39th St., New York City, Dec. 8-13.

Franklin Institute of Pennsylvania, Centenary Celebration at Philadelphia, Sept. 17-19.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Briarcliff Lodge, Briarcliff Manor, N. Y., Oct. 27-31.

International Union of Steam and Operating Engineers. Dave Evans, 6334 Yale Ave., Chicago, Ill. Biennial convention at Detroit, Mich., Sept. 8-13.

National Association of Practical Refrigerating Engineers. E. H. Fox, 5707 West Lake St., Chicago, Ill. Convention at New Orleans, La., Nov. 11-14. Exhibits at the Isaac Delgado High School.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Hotel Pantlind, Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Michigan Association** at Grand Rapids, Sept. 8. Wm. H. Yeomans, 209 Plainfield Ave., Grand Rapids. **Pennsylvania State Association** at Grand Rapids, Mich., Sept. 8. J. N. Calvert, Union & Ridenour Ave., Crafton, Pittsburgh, Pa.

National Exposition of Power and Mechanical Engineering. C. F. Roth, Grand Central Palace, New York City. Annual exposition at New York City, Grand Central Palace, Dec. 1-6.

National Safety Council, W. H. Cameron, 168 N. Michigan Ave., Chicago, Ill. Thirteenth Annual Safety Congress at Louisville, Ky., Sept. 29 to Oct. 3.

New England Water-Works Association, Frank T. Gifford, 715 Tremont Temple, Boston, Mass. Annual convention at Powers Hotel, Buffalo, N. Y., Sept. 23-26.

Trade Catalogs

Boilers—Union Iron Works, Erie, Pa. A well illustrated catalog has just been published which describes the new departure in design and construction of the Union Universal Boiler built by this company.

Packing—The Garlock Packing Co., Palmyra, N. Y., have recently sent out an interesting device called the "Mystic Oracle; Packing Problems Solved by Wireless." It will tell you automatically the kind of packing that you should use when you turn the disk containing the questions you want answered directly under the pointer.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Aug. 4, 1924	Aug. 11, 1924
Pool 1	New York	$2.70	$2.35
Smokeless	Columbus	2.10	2.25
Clearfield	Boston	1.90	2.35
Sonerset	Boston	2.05	2.40
Kanawha	Columbus	1.45	1.55
Ho.king	Columbus	1.55	1.65
Pittsburgh No. 8	Cleveland	1.85	1.90
Franklin, Ill.	Chicago	2.35	2.50
Central, Ill.	Chicago	2.10	2.25
Ind. 4th Vein	Chicago	2.35	2.50
West Ky.	Louisville	1.55	1.85
S. E. Ky.	Louisville	1.55	1.75
Big Seam	Birmingham	1.75	2.00

FUEL OIL

New York—Aug. 14, light oil, tank-car lots, 28@34 deg. Baumé, 4⅜c. per gal., 36@40 deg. 5¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Aug. 6, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.75; 32@36 deg., gas oil, 4½c. per gal.; 38@40 deg., 5½c. per gal.

Pittsburgh—Aug. 3, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.; 34 deg., neutral, 8½c. per gal.

Dallas—Aug. 8, f.o.b. local refinery, 26@30 deg., deg., $1.25 per bbl.

Philadelphia—Aug. 8, 28@30 deg., $2.05@$2.113 per bbl.; 18@22 deg., $2.075@$2.139; 13@16 deg., $1.78½@$1.848 per bbl.

Boston—Aug. 4, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4⅞c. per gal., light oil, 28@32 deg. Baumé, 6⅞c. per gal.

Cincinnati—Aug. 12, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 4⅜c. per gal.; 26@30 deg., 4½c. per gal.; 30@32 deg., 5c. per gal.

Chicago—Aug. 12, 20@22 deg., 5½c. per gal.; 24@26 deg., 6c. per gal.; 28@30 deg., 6c. per gal.

New Plant Construction

Ala., Dothan—The City has voted to issue $750,000 bonds for the completion of the hydro-electric plant at Chalkers Bluff, near Dothan. When completed this plant will supply both light and power to Dothan.

Calif., Bakersfield — The Fairfax School District, L. S. Abel, Clerk, plans to purchase one electric pressure pumping plant, 500 gal. capacity per hr.

Calif., Beverly Hills — The Globe Ice Cream Co., 230 West Jefferson St., Los Angeles, is having plans prepared for an ice and ice cream manufacturing plant on Santa Monica Blvd. Estimated cost $250,000.

Calif., San Francisco — The Sanitary Laundry Co., 15 McCoppin St., plans to construct a laundry on 17th St. Estimated cost, $40,000. B. Dietrich is president.

Calif., Watsonville—The Union Ice Co., 354 Pine St., plans to construct an ice manufacturing and cold storage plant. Estimated cost between $350,000 and $500,000.

Colorado—The Bureau of Reclamation, Department of the Interior, Denver, will receive bids until Sept. 16, for furnishing four water wheel driven pumping units for the Orchard Mesa pumping plant, Grand Valley Project. Two of the units will pump 30 sec. ft. each to a height of 130 ft. and two will pump 40 sec. ft. each to a height of 41 ft.

Del., Reedy Island — Treasury Department, Supervising Architect's Office, Washington, D. C., will receive bids until Aug. 28 for new water pumps, etc., at U. S. Quarantine Station, here.

Ill., Springfield—The City is having plans prepared by Burns & McDonnell, Engineering Co., Engineers, 402 Interstate Bldg., Kansas City, Mo., and will receive bids in September for extensive improvements to its main power plant and for a 10,000,000 gal. filtration system and softening plant.

Ind., Marion—The City plans to construct and equip a new lighting plant. Address Board of Public Works.

La., Cottonport — The Town is having plans prepared by Henry A. Mentz, Consulting Engineer, Magnolia, for the installation of an electric light plant and waterworks system. Estimated cost $50,000.

Mass., Montague City—Plans are being considered for the installation of a municipal lighting plant. Address E. L. Faber.

Mich., Iron Mountain — The Board of Water Commissioners will receive bids until Aug. 25, for furnishing labor, material and equipment for filtration plant and high service pumping station. Motor driven centrifugal pump will be furnished under separate contract. Hoad, Decker, Shoecraft & Drury, 303 South State St., Ann Arbor, are Engineers.

Minn., Virginia—The City Council has voted to issue $40,000 bonds to extend the municipal heating system. A. E. Bickford, is city clk.

Miss., Holly Springs—The Holly Springs Ice & Coal Co., recently organized, will construct an ice plant. Estimated cost $15,000. Address J. C. Price, Batesville.

Miss., Shuqualak—The Mayor and Board of Aldermen will receive bids until Sept. 4, for furnishing materials and constructing waterworks and electric light plant improvements, including oil engine pump, alternator switchboard, etc. Henry A. Mintz, Magnolia is consulting Engineer.

Mo., Doniphan—The Doniphan Light & Ice Co. is having preliminary plans prepared for an electric light and ice making plant. Equipment, including two 60-hp. engines of oil burning type, switchboard, etc. will be installed.

Mo., Hartville—The City plans to construct a power plant and will be in the market for a 42 kva. waterwheel driving a 3-phase, 60-cycle, 2,300 volt alternator. Also a 25-hp. oil engine belted to a 25 kva. alternator and a switchboard. Bids were taken on this project July 7 but no award was made because of condemnation proceedings for right-of-way. New bids will be taken later. Alexander Engineering Co., Springfield, are Engineers.

Every one of these items is reported by our authorized correspondents who are instructed to verify every item sent in. This free weekly service is published in the interests of the buyer and the seller, to bring them together and get machinery moving.

Everything possible is done to insure authenticity and timeliness.

Your co-operation is invited in helping us maintain this service at the highest efficiency.

BUSINESS NEWS DEPARTMENT
Tenth Ave. at 36th St., New York

Mo., St. Joseph—The City plans to install an electric lighting plant and improve the street lighting. Work will consist of the installation of a Diesel oil engine unit, changing the existing direct current street lighting system to a series alternating current system, converting 750 magnetite arc lighting units to incandescent units, etc. The report of Arthur L. Mullergren, consulting engineer, Kansas City, is now before the City Officials. C. D. Fox, is superintendent of the Municipal Lighting Plant.

N. Y., Hoosick Falls—The Twin State Gas & Electric Co., 160 State St., Boston, is receiving bids for improvements to its hydro-electric plant, with two additional units. Two additional generators and two vertical waterwheels will be installed. R. G. Andrus, c/o Owners, is Engineer.

N. C., Southern Pines—The Mayor and Board of Town Commissioners will receive bids until Aug. 26 for a pumping station, motor driven centrifugal pump and accessories, etc., in connection with the waterworks and sewage disposal plant. Gilbert C. White Co., Durham, are Engineers.

N. D., Grand Forks—The City Commissioners have received the report of Arthur L. Mullergren, consulting engineer, Kansas City, Mo., for a municipal electric light plant and distribution system to serve the entire city. The cost of the complete project is $610,000. Bonds to the amount of $110,000 have been voted for the initial development for water pumping and street lighting only. The Commissioners are considering the advisement of installing the new plant or making an agreement with the Northern States Power Co. of purchasing wholesale current for its requirements. Henry O'Keefe, Jr., is mayor.

Ohio, Cleveland—The City is having preliminary plans prepared for the construction of a pumping station and filtration plant. Estimated cost $1,000,000. H. Wright is Director of Public Utilities. Herman Kregeline, City Hall, is Engineer.

Ohio, Dayton—The City plans improvements to the waterworks, including remodeling and enlarging steam pumping plant at Keowee St., installation of 6 m.g. per day high service pumping unit, etc. Total estimated cost $4,200,000. G. M. Baker, is director Public Service.

Okla., Hominy—The City plans to install a new water supply system. Project will include pump houses and deep well motor driven pumps. Estimated cost $85,000. W. C. Parness, is city clk. Engineer not selected at the time report was made.

Okla., Newkirk—The City will install a new water supply system, including triplex motor driven pumps in Kelly wells, etc. Project was voted down last winter but has been revived. Estimated cost $110,000. F. B. King, Grain Exchange Bldg., Oklahoma City, is engineer.

Okla., Okemah—The City will hold an election Aug. 29 to vote on $25,000 bonds for enlarging the filter plant, including motor driven centrifugal pumps, flow line, etc. J. S. Price, is city clerk.

Penn., Germantown—Bids will be received until Aug. 22, by Arthur H. Brockie, Architect, 254 South 15th St., Philadelphia, for a 1-story, 61 x 97 ft. power house addition to the Germantown Dispensary and Hospital.

Tex., Beaumont—L. J. Block, Chairman of the Waterworks Comn., will receive bids until Aug. 26, for Waterworks improvements, including filter building and headhouse and equipment for four 1,000,000 gal. units. Estimated cost, $125,000. Burns & McDonnell Engineering Co., 402 Interstate Bldg., Kansas City, Mo., are engineers.

Tex., Kingsville — The State Bd. of Regents, Austin, will receive bids until Aug. 26, for the construction of a power house and equipment in connection with a new addition to the South Texas State Teacher's College, here. Estimated cost, $60,000. Endress & Cato, Bankers Mortgage Bldg., Houston, are engineers.

Tex., San Antonio—The Glaze Ice & Fuel Co., 119 Pierce Ave., plans to construct an ice plant at Pine and Van Ness Sts. Estimated cost $40,000.

Tex., Tahoka—The City is having plans prepared by the Elrod Engineering Co., 3124 Elm St., Dallas, for a municipal ice plant. Estimated cost $40,000.